INTERSTATE 5 COLUMBIA RIVER CROSSING

Conceptual Stormwater Design Report

May 2008

Columbia River CROSSING

TO:	Readers of the CRC Technical Reports
FROM:	CRC Project Team
SUBJECT:	Differences between CRC DEIS and Technical Reports

The I-5 Columbia River Crossing (CRC) Draft Environmental Impact Statement (DEIS) presents information summarized from numerous technical documents. Most of these documents are discipline-specific technical reports (e.g., archeology, noise and vibration, navigation, etc.). These reports include a detailed explanation of the data gathering and analytical methods used by each discipline team. The methodologies were reviewed by federal, state and local agencies before analysis began. The technical reports are longer and more detailed than the DEIS and should be referred to for information beyond that which is presented in the DEIS. For example, findings summarized in the DEIS are supported by analysis in the technical reports and their appendices.

The DEIS organizes the range of alternatives differently than the technical reports. Although the information contained in the DEIS was derived from the analyses documented in the technical reports, this information is organized differently in the DEIS than in the reports. The following explains these differences. The following details the significant differences between how alternatives are described, terminology, and how impacts are organized in the DEIS and in most technical reports so that readers of the DEIS can understand where to look for information in the technical reports. Some technical reports do not exhibit all these differences from the DEIS.

Difference #1: Description of Alternatives

The first difference readers of the technical reports are likely to discover is that the full alternatives are packaged differently than in the DEIS. The primary difference is that the DEIS includes all four transit terminus options (Kiggins Bowl, Lincoln, Clark College Minimum Operable Segment (MOS), and Mill Plain MOS) with each build alternative. In contrast, the alternatives in the technical reports assume a single transit terminus:

- Alternatives 2 and 3 both include the Kiggins Bowl terminus
- Alternatives 4 and 5 both include the Lincoln terminus

In the technical reports, the Clark College MOS and Mill Plain MOS are evaluated and discussed from the standpoint of how they would differ from the full-length Kiggins Bowl and Lincoln terminus options.

Difference #2: Terminology

Several elements of the project alternatives are described using different terms in the DEIS than in the technical reports. The following table shows the major differences in terminology.

DEIS terms	Technical report terms
Kiggins Bowl terminus	I-5 alignment
Lincoln terminus	Vancouver alignment
Efficient transit operations	Standard transit operations
Increased transit operations	Enhanced transit operations

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Difference #3: Analysis of Alternatives

The most significant difference between most of the technical reports and the DEIS is how each structures its discussion of impacts of the alternatives. Both the reports and the DEIS introduce long-term effects of the full alternatives first. However, the technical reports then discuss "segment-level options," "other project elements," and "system-level choices." The technical reports used segment-level analyses to focus on specific and consistent geographic regions. This enabled a robust analysis of the choices on Hayden Island, in downtown Vancouver, etc. The system-level analysis allowed for a comparative evaluation of major project components (replacement versus supplemental bridge, light rail versus bus rapid transit, etc). The key findings of these analyses are summarized in the DEIS; they are simply organized in only two general areas: impacts by each full alternative, and impacts of the individual "components" that comprise the alternatives (e.g. transit mode).

Difference #4: Updates

The draft technical reports were largely completed in late 2007. Some data in these reports have been updated since then and are reflected in the DEIS. However, not all changes have been incorporated into the technical reports. The DEIS reflects more recent public and agency input than is included in the technical reports. Some of the options and potential mitigation measures developed after the technical reports were drafted are included in the DEIS, but not in the technical reports. For example, Chapter 5 of the DEIS (Section 4(f) evaluation) includes a range of potential "minimization measures" that are being considered to reduce impacts to historic and public park and recreation resources. These are generally not included in the technical reports. Also, impacts related to the stacked transit/highway bridge (STHB) design for the replacement river crossing are not discussed in the individual technical reports, but are consolidated into a single technical memorandum.

Title VI

The Columbia River Crossing project team ensures full compliance with Title VI of the Civil Rights Act of 1964 by prohibiting discrimination against any person on the basis of race, color, national origin or sex in the provision of benefits and services resulting from its federally assisted programs and activities.

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Cover Sheet

Interstate 5 Columbia River Crossing

Conceptual Stormwater Design Report:

Submitted By:

Roger Kitchin

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TABLE OF CONTENTS

Exhibits

ACRONYMS

ADT	Average Daily Traffic
API	Area of Potential Impact
BES	City of Portland Bureau of Environmental Services
BRT	Bus Rapid Transit
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HCT	High Capacity Transit
I-5	Interstate 5
LRT	Light Rail Transit
MP	Mile Post
NOAA	National Oceanic & Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
PGIS	Pollution-Generating Impervious Surface
ODEQ	Oregon Department of Environmental Quality
ODOT	Oregon Department of Transportation
SR	State Route
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
TriMet	Tri-County Metropolitan Transportation District of Oregon
TSS	Total Suspended Solids
WSDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation

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1. Introduction

1.1 Background

Interstate 5 (I-5), the only continuous north-south interstate highway on the West Coast, provides a commerce link for the United States, Canada, and Mexico. In the Vancouver-Portland area, I-5 is one of two major highways that provide interstate connectivity and mobility. The 5-mile segment of I-5 between State Route (SR) 500 in Vancouver and Columbia Boulevard in Portland directly influences the operation of the I-5 crossing over the Columbia River. This segment includes interchanges with three state highways (SR 14, SR 500, and SR 501) and five major arterial roadways that serve a variety of land uses, and provides access to downtown Vancouver, two international ports, industrial centers, residential neighborhoods, retail centers, and recreational areas.

The Columbia River Crossing project, which is being led by the Oregon Department of Transportation (ODOT) and Washington State Department of Transportation (WSDOT), is aimed at improving the mobility, reliability, and accessibility for automobile, freight, transit, bicycle, and pedestrian users of the I-5 corridor. The team also includes Metro, Southwest Washington Regional Transportation Council, Tri-County Metropolitan Transportation District of Oregon (TriMet), Clark County Public Transit Benefit Area Authority, and the cities of Portland and Vancouver.

1.2 Site Location

Exhibit 1-1 shows the corridor for this multi-modal project and primary area of potential impact (API) adopted for the Draft Environmental Impact Statement (DEIS). Note that the project footprint referenced in this report is an envelope that comprises the overall extent of the proposed construction for all alternatives being considered in the DEIS and, as such, is smaller than the API. This footprint encompasses the area of most interest from a drainage perspective; namely, new and reconstructed impervious pavement and transit guideway.

Using the Oregon and Washington State Department of Transportation Mile Post (MP) systems as a reference, the API comprises the I-5 corridor in Oregon from MP 306.50, which is just south of North Victory Boulevard, to the Oregon-Washington State boundary (MP 308.38). In Washington State, the API comprises the I-5 corridor and parts of Vancouver from the State boundary (MP 0.00) to the Main Street Interchange (MP 3.06).

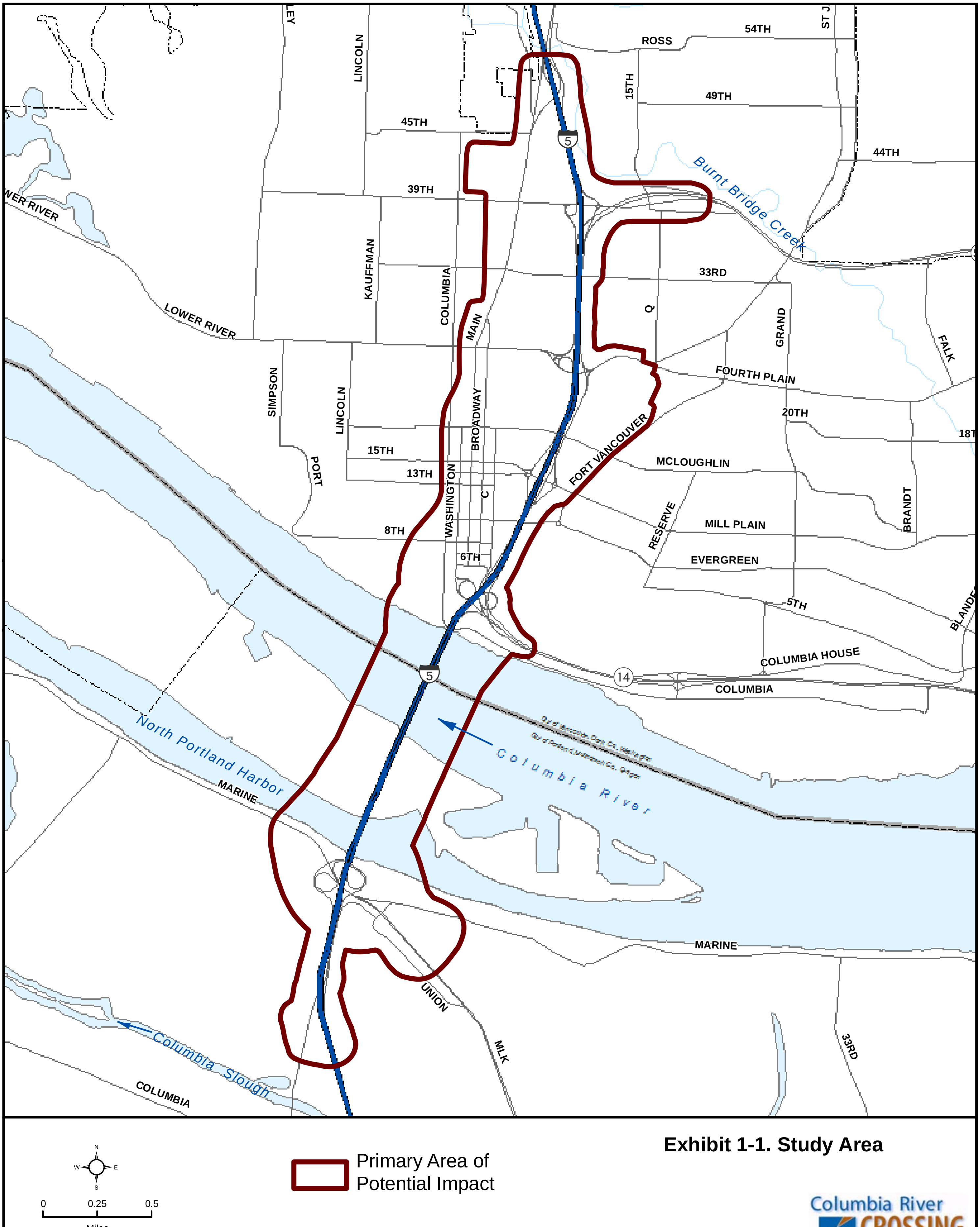
A proposed highway improvement project, the I-5 Delta Park project, abuts the south end of the Columbia River Crossing project and is currently in final design. Overlap between the two projects is expected to be limited to ramp construction.

1.3 Scope of Work

The scope of this report is to describe the existing drainage and relevant features in the project footprint, and to present a conceptual approach for managing runoff and conceptual layouts for proposed major stormwater-related infrastructure.

1.4 Vertical Datum

Elevations presented in this report are referenced to the North American Vertical Datum of 1988.



Primary Area of Potential Impact

Exhibit 1-1. Study Area

Columbia River CROSSING

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2. Existing Conditions

This section describes the physical setting and existing stormwater infrastructure for the project corridor.

2.1 Geography

As shown on Exhibit 2-1, the Columbia River dominates the topography of the project area. The project corridor lies within the Columbia River main valley except for the area south of North Portland Harbor, which is within the Columbia Slough watershed, and a small area at and north of the SR 500 interchange, which is within the Burnt Bridge Creek watershed. Elevations vary from approximately ten feet south of North Portland Harbor to about 220 feet at the drainage divide between the Columbia River and Burnt Bridge Creek valleys.

Columbia Slough drains to the Willamette River while Burnt Bridge Creek flows into Vancouver Lake before discharging to the Columbia River. Within the project area, the Columbia Slough watershed mainly comprises what used to be the Columbia River floodplain. A levee system now protects the area against flooding from Columbia Slough and Columbia River up to the one percent[1] event.

South of the Columbia River, the project is located entirely in the relatively flat and low-lying floodplain. Drainage within the floodplain is not well-defined and Columbia Slough, which is located south of the project, actually discharges into the Willamette River. North of the Columbia River, the project is located on gently sloped valley sides.

2.2 Climate

The National Oceanic & Atmospheric Administration (NOAA) website[2] describes summers in the project area as short, dry and warm; spring, winter and fall are typically cool and wet. The Coast Range offers limited shielding from the Pacific Ocean storms while the Cascades provide an orographic lift of moisture-laden westerly winds, resulting in moderate rainfall. Nearly 90 percent of the average annual rainfall of 36.3 inches occurs from October through May. The maximum 24-hour rainfall of 4.44 inches occurred in October 1994. Snowfall accumulations are rarely more than two inches, and usually melt within a couple of days.

Average monthly temperatures taken at Portland Airport vary from 39.6 ºF in January to 68.6 ºF in August. The maximum and minimum recorded temperatures of 107 ºF and -3 ºF occurred in August 1981 and February 1950, respectively. Surface winds seldom exceed sustained wind speeds at 50 mph and have rarely exceeded 75 mph.

[1] This is a flood with a 1 percent probability of occurring in any given year. It is also referred to as the 100-year or base flood.
[2] http://www.wrh.noaa.gov/pqr/pdxclimate/,

2.3 Surficial Soils

Exhibit 2-2 shows the approximate areal extent of the surficial soils in the vicinity of the project. Their descriptions, below, are from the National Resources Conservation Service website[3].

The Sauvie-Rafton-Urban land complex belongs to Hydrologic Soil Group D, the Pilchuck-Urban land complex belongs to Group A, and the Wind River and Lauren soils belong to Group B. A soil survey[4] indicates that water tables are at a depth of less than one foot for the Sauvie-Rafton-Urban land complex, and between two and four feet for the Pilchuck-Urban land complex. Depths to water table are not provided for the Wind River and Lauren soils[5]. The hydrologic properties of the three Groups referenced are:

- Group A soils have a high infiltration rate and consist mainly of deep, well drained to excessively drained sands or gravelly sands.
- Group B soils have a moderate infiltration rate and consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture
- Group D soils have high runoff potential and primarily consist of clay soils that have high swelling potential, a permanent high water table, or a clay layer at or near the surface, and shallow soils over nearly impervious material.

No tests have been performed to determine site-specific infiltration rates or groundwater levels.

2.4 Aquifers

South of the Columbia River, only one well has been identified in the proximity of the project corridor. It is located less than 50 feet east of the northbound shoulder of I-5 on Hayden Island, close to the North Portland Harbor bridge abutment. The well, which is owned by the City of Portland, is not currently in operation and there is no wellhead protection zone in place at this time.

North of the Columbia River, I-5 lies above the Troutdale Aquifer. This aquifer provides water supplies for the City of Vancouver, and the City has designed the entire area within its boundary as a Critical Aquifer Recharge Area[6]. Exhibit 2-3 shows wells in the vicinity of the API and Special Protection Zones that encompasses land within 1,900 feet of the wellheads. In addition, the U.S. Environmental Protection Agency (EPA) recently designated the Troutdale Aquifer as a Sole Source Aquifer[7]. Section 3.4.2 discuses project-specific aquifer-related issues.

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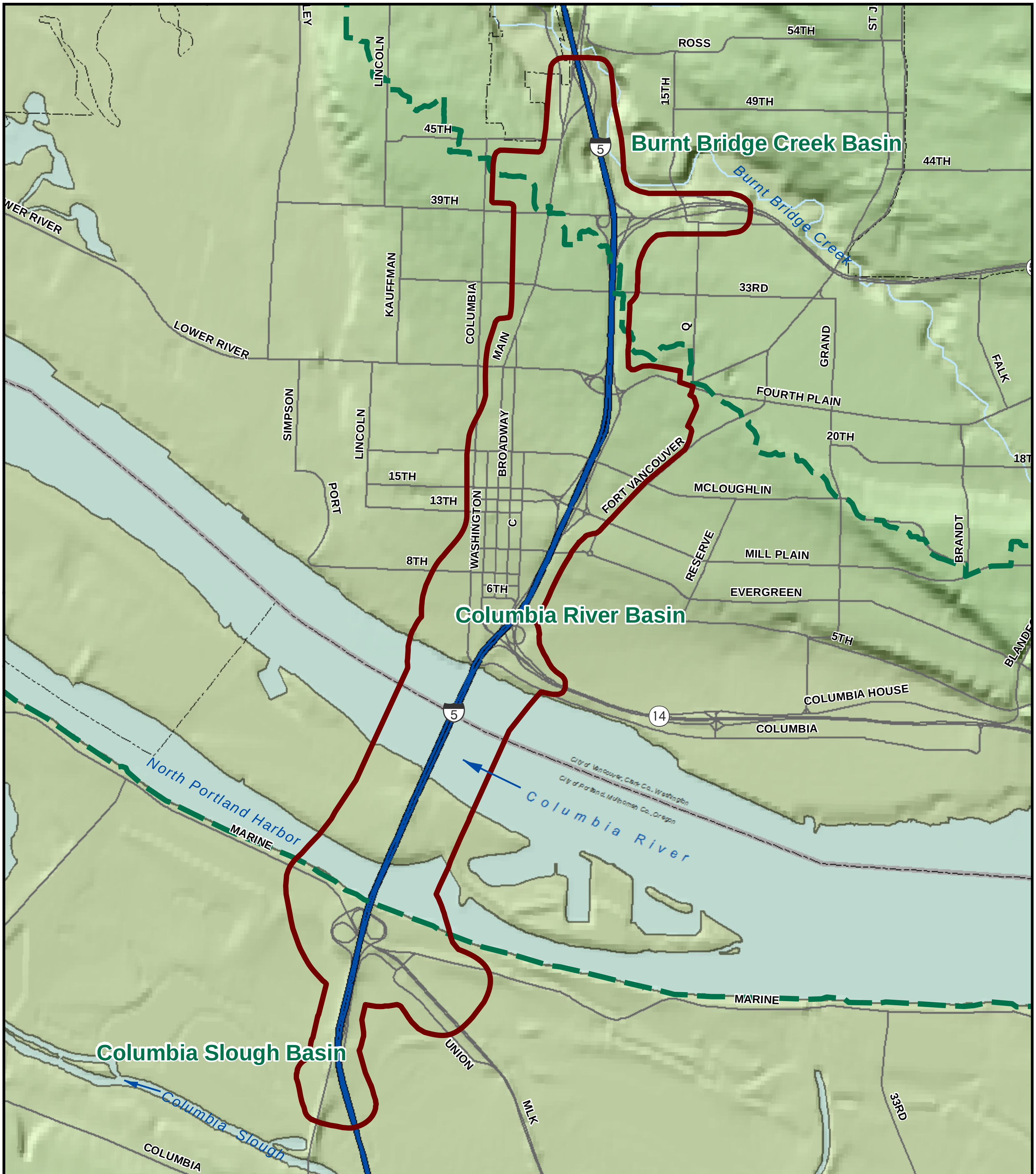
[3] http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
[4] *Soil Survey of Multnomah County, Oregon*. United States Department of Agriculture, Soil Conservation Service, in cooperation with Oregon Agricultural Experiment. August 1983.
[5] *Soil Survey of Clark County, Washington*. United States Department of Agriculture, Soil Conservation Service, in cooperation with the Washington Agricultural Experiment Station. November 1972.
[6] *Vancouver Municipal Code, Title 14 Water and Sewers*. City of Vancouver. Document accessed online in June 2007.
[7] A sole source aquifer is one "which supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer, and for which there is no alternative source or combination of alternative drinking water sources which could physically, legally and economically supply those dependent upon the aquifer."



Primary Area of Potential Impact

Drainage Divide

0 0.25 0.5

Miles

Exhibit 2-1: Topography

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Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit2_1_RK080.mxd

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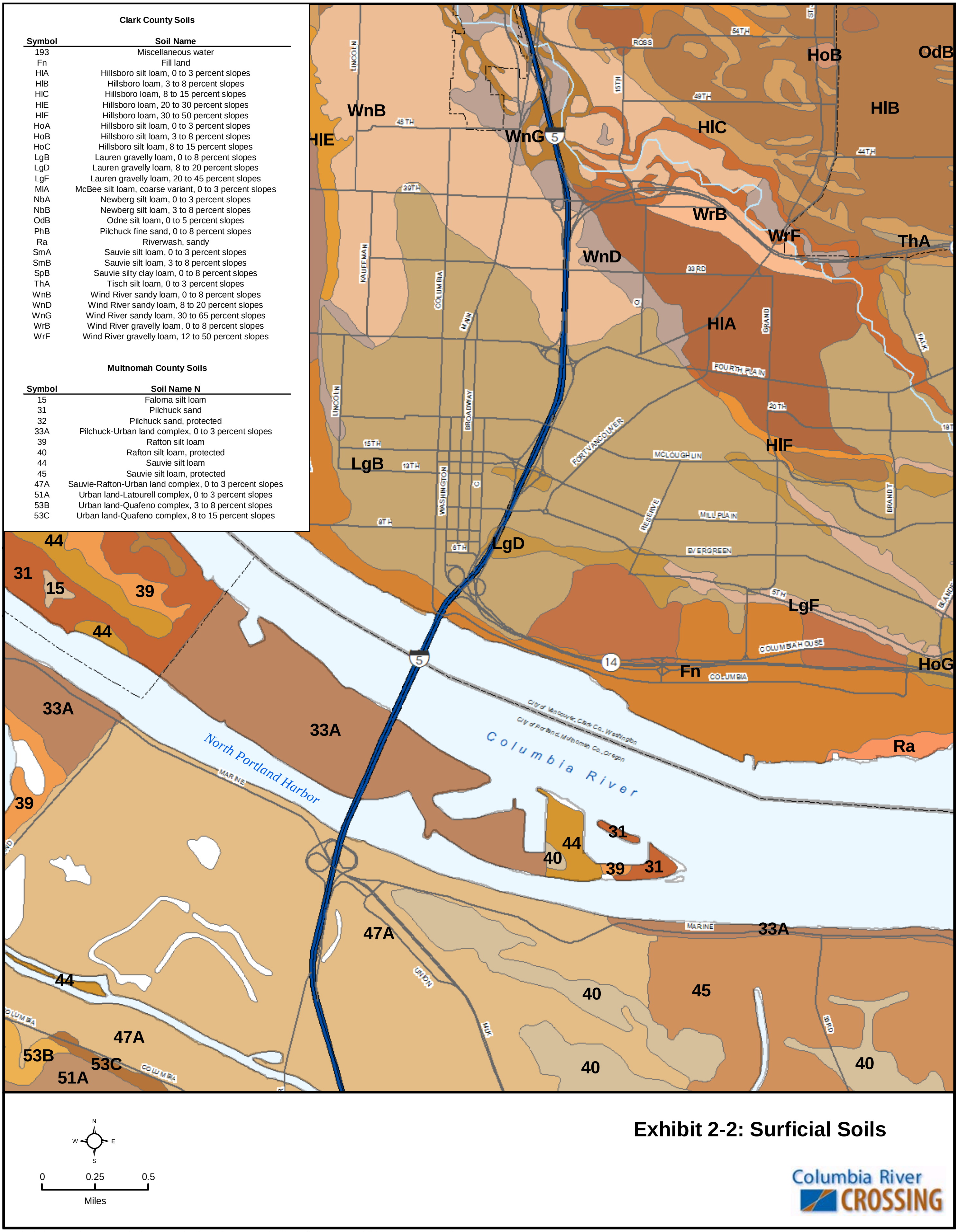

Clark County Soils

Symbol	Soil Name
193	Miscellaneous water
Fn	Fill land
HlA	Hillsboro silt loam, 0 to 3 percent slopes
HlB	Hillsboro loam, 3 to 8 percent slopes
HlC	Hillsboro loam, 8 to 15 percent slopes
HlE	Hillsboro loam, 20 to 30 percent slopes
HlF	Hillsboro loam, 30 to 50 percent slopes
HoA	Hillsboro silt loam, 0 to 3 percent slopes
HoB	Hillsboro silt loam, 3 to 8 percent slopes
HoC	Hillsboro silt loam, 8 to 15 percent slopes
LgB	Lauren gravelly loam, 0 to 8 percent slopes
LgD	Lauren gravelly loam, 8 to 20 percent slopes
LgF	Lauren gravelly loam, 20 to 45 percent slopes
MlA	McBee silt loam, coarse variant, 0 to 3 percent slopes
NbA	Newberg silt loam, 0 to 3 percent slopes
NbB	Newberg silt loam, 3 to 8 percent slopes
OdB	Odne silt loam, 0 to 5 percent slopes
PhB	Pilchuck fine sand, 0 to 8 percent slopes
Ra	Riverwash, sandy
SmA	Sauvie silt loam, 0 to 3 percent slopes
SmB	Sauvie silt loam, 3 to 8 percent slopes
SpB	Sauvie silty clay loam, 0 to 8 percent slopes
ThA	Tisch silt loam, 0 to 3 percent slopes
WnB	Wind River sandy loam, 0 to 8 percent slopes
WnD	Wind River sandy loam, 8 to 20 percent slopes
WnG	Wind River sandy loam, 30 to 65 percent slopes
WrB	Wind River gravelly loam, 0 to 8 percent slopes
WrF	Wind River gravelly loam, 12 to 50 percent slopes

Multnomah County Soils

Symbol	Soil Name N
15	Faloma silt loam
31	Pilchuck sand
32	Pilchuck sand, protected
33A	Pilchuck-Urban land complex, 0 to 3 percent slopes
39	Rafton silt loam
40	Rafton silt loam, protected
44	Sauvie silt loam
45	Sauvie silt loam, protected
47A	Sauvie-Rafton-Urban land complex, 0 to 3 percent slopes
51A	Urban land-Latourell complex, 0 to 3 percent slopes
53B	Urban land-Quafeno complex, 3 to 8 percent slopes
53C	Urban land-Quafeno complex, 8 to 15 percent slopes

Exhibit 2-2: Surficial Soils

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2.5 Land Use

Exhibit 2-4 shows the general land use in the vicinity of the project corridor.

South of the Columbia River, land west of I-5 between Victory Boulevard and North Portland Harbor generally has an Industrial zoning designation while land to the east is generally designated as Open Space. On Hayden Island, land in the vicinity of the project corridor is zoned Commercial.

North of the Columbia River, areas either side of the highway, especially west of I-5, have extensive residential and commercial development. The Pearson Airfield, Clark College and Fort Vancouver Historic Park, which are low density developments, are located east of I-5, between SR 14 and Fourth Plain Boulevard.

Airports, like Pearson Airfield, have specific stormwater-related issues that should be noted. Ponds typically provided for stormwater flow control and treatment may be an attractant for wildlife considered hazardous to airport operations, specifically collisions between birds and aircraft approaching and departing from airports. While this is not likely to be an issue with Portland International Airport, it is expected to be a consideration for Pearson Airfield and further discussion may be found in Section 3.4.3. For airports like Pearson that normally serve piston-powered aircraft, the Federal Aviation Administration (FAA) recommends a separation distance of 5,000 feet between any hazardous wildlife attractants such as stormwater ponds. The airport's Air Operations Area as shown on Exhibit 2-5.

2.6 Drainage

A separate report[8] describes the existing stormwater management systems in greater detail. Exhibits 2-6a through 2-6d show existing major existing stormwater and drainage features within the API. In general, continuous curbs and concrete barriers confine runoff from I-5 to the highway, and closed (pipe) drainage systems convey flows to surface water outfalls. Runoff from bridges across North Portland Harbor and Columbia River drain through scuppers to the ground or water surface below. The only water quality facilities provided for runoff from I-5 are located in the Burnt Bridge Creek watershed and north of the SR 500 interchange. The Interstate MAX line has only one flow control facility within the API; it is located at the Delta Park & Ride.

North Portland Harbor, a branch of the Columbia River, Columbia River and Cold Creek are the only watercourses that cross the project corridor within the API. Although Burnt Bridge Creek does cross I-5, it does so north of the API.

2.6.1 Oregon

I-5 is elevated on embankments or structures and, in general, the highway drainage systems do not handle runoff from outside the right-of-way. South of North Portland Harbor, I-5 lies entirely

[8] *Stormwater: Existing Infrastructure*. Columbia River Crossing Project, June 2006.

within the Columbia Slough Watershed[9]. A levee system, part of which is the I-5 embankment, protects most of the floodplain in the vicinity of I-5 against flooding. Martin Luther King Jr. Boulevard, located east of the Marine Drive interchange, is also part of this levee system.

Most of the runoff from I-5 drains east to Schmeer Slough or Walker Slough and is discharged to Columbia Slough via a pump station located on Schmeer Road. Both sloughs are in Peninsula Drainage District No. 2. The two exceptions are:

1. The southwest quadrant of the Marine Drive interchange flows into the Vanport Wetland, which is in the Peninsula Drainage District No. 1. A pump station located near the Portland International Raceway discharges runoff to Columbia Slough.
2. The northwest quadrant of the Marine Drive interchange, which discharges through the levee to North Portland Harbor. Technically, this is an inter-watershed transfer.

On Hayden Island, runoff from I-5 flows directly to the Columbia River.

Runoff from the Light Rail Transit (LRT) track between the Delta Park and Expo stations, and from the Expo station and associated parking area is discharged to the Vanport Wetland. Runoff from the Delta Park station and adjacent parking areas is discharged to Schmeer Slough, while runoff from overflow parking west of North Expo Road drains west to Northern Slough. Flows in Schmeer Slough and Northern Slough are pumped to Columbia Slough.

2.6.2 Washington State

Runoff from I-5 South of the SR 500 interchange is discharged to the Columbia River via a 5-foot diameter outfall. A pump station located southeast of the SR 14 interchange discharges runoff from lower lying portions of I-5 when the Columbia River is in flood.

South of SR 500, I-5 is generally below the surrounding areas and the highway drainage system also receives runoff from developed areas west of the highway right-of-way. These areas are:

- About 40 acres of downtown Vancouver that flows into the I-5 conveyance system immediately north of the SR 14 interchange.
- Three separate drainage systems serving a combined area of approximately 180 acres, which flows into the I-5 system at Mill Plain Boulevard.
- An area of approximately 35 acres that flows into the I-5 system at 31st Street.

Runoff from neighborhoods east of I-5 and south of 29th Street also flow into the I-5 drainage system. These areas, however, mostly comprise open spaces and public facilities.

[9] *Draft 2005 Portland Watershed Management Plan.* Bureau of Environmental Services, City of Portland. October 2005.

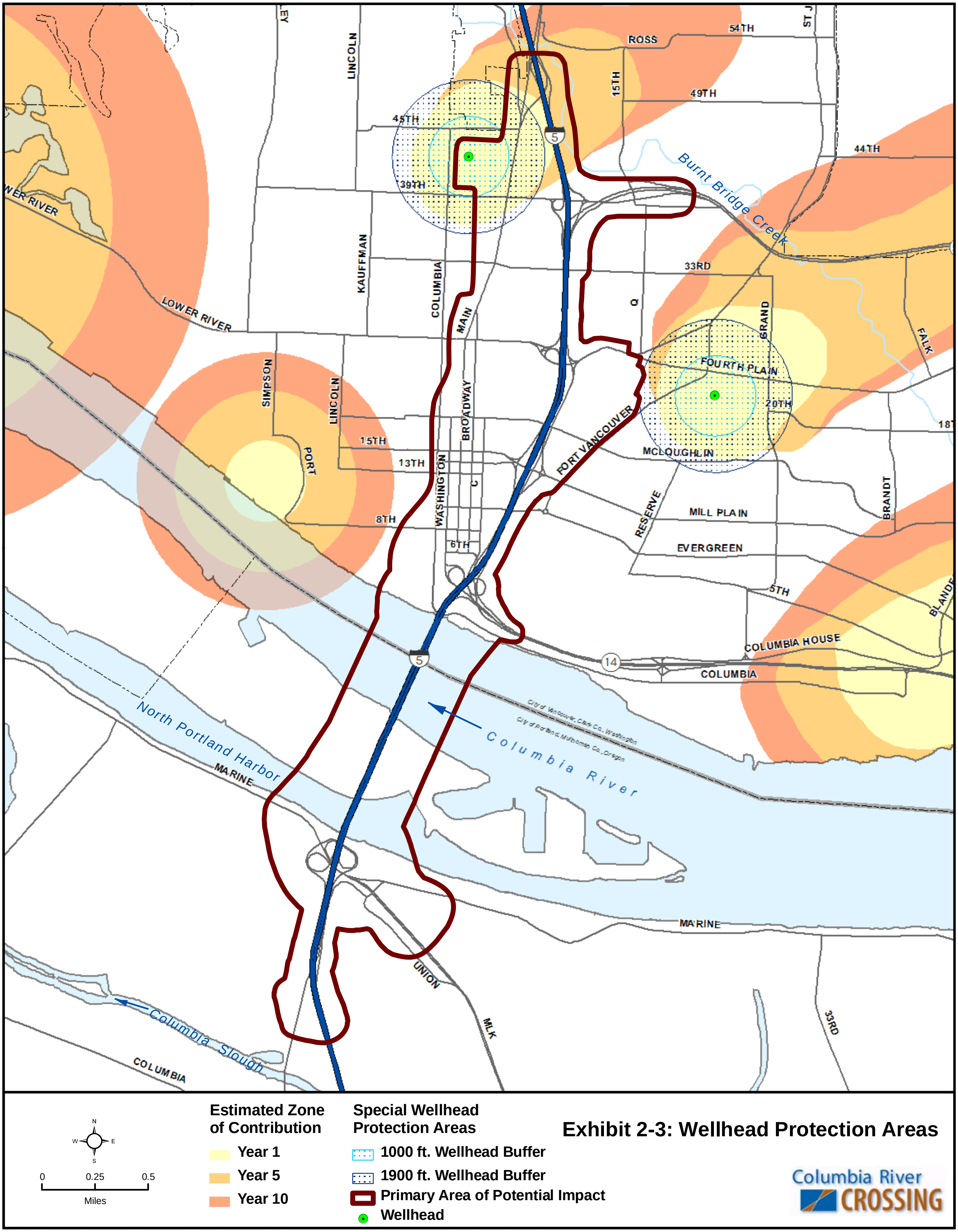

Exhibit 2-3: Wellhead Protection Areas

Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit3_2_RK080_WellheadProtection.mxd

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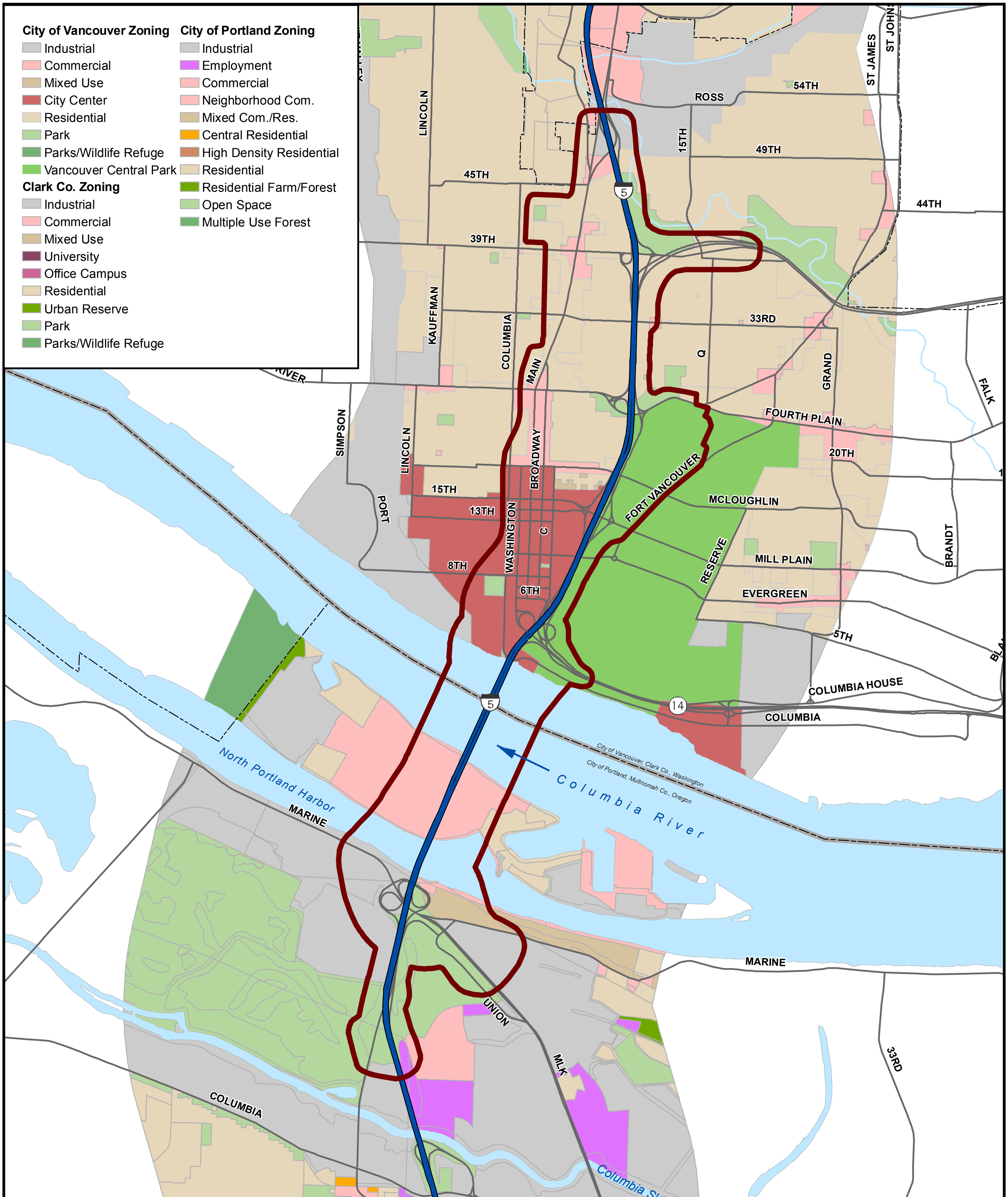

N
W E
S

0 0.5 1

Miles

Primary Area of Potential Impact

Exhibit 2-4: Land Use

Sources: Clark County GIS, RLIS, City of Portland

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Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit2_4_RK080.mxd

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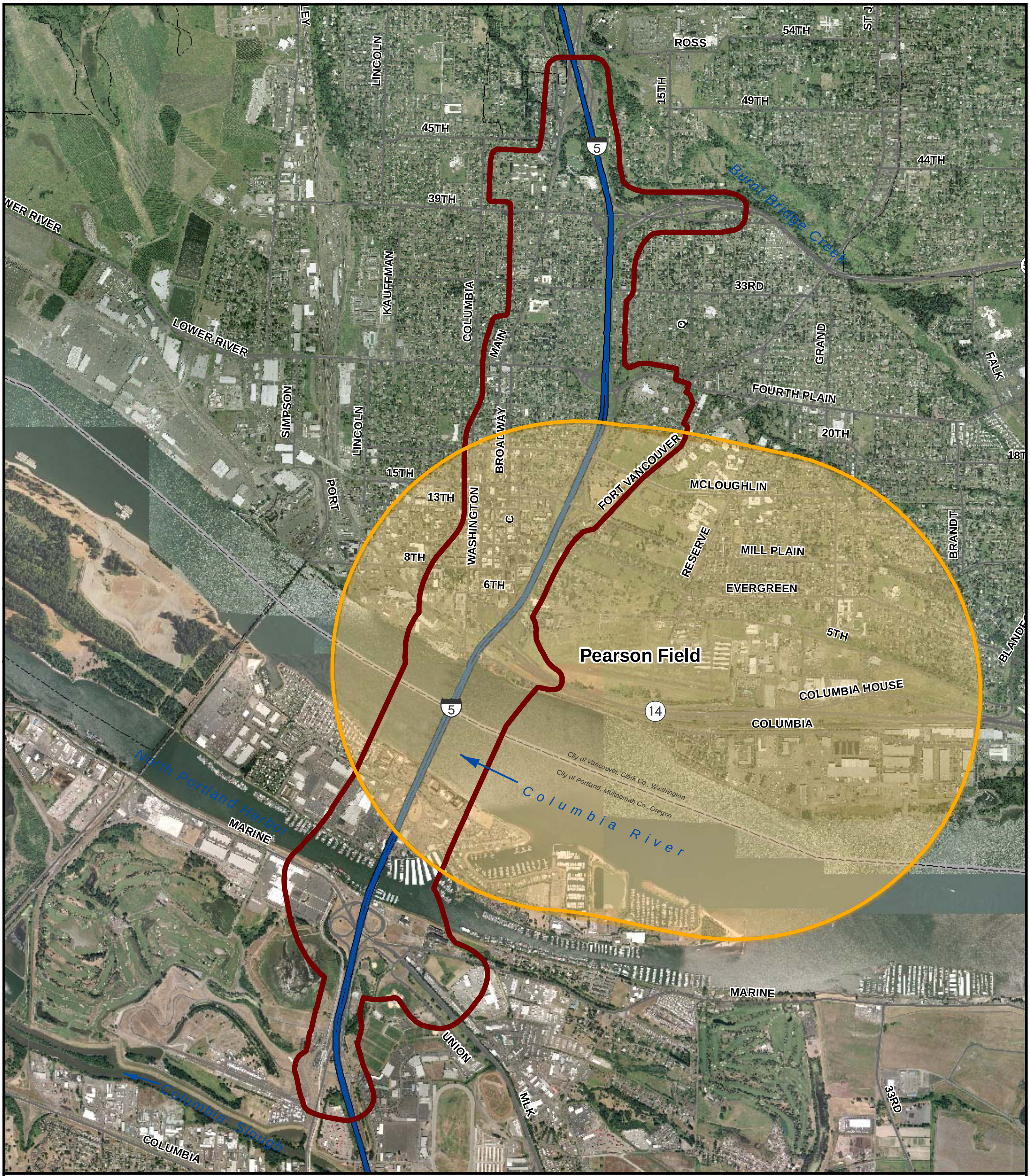

Primary Area of Potential Impact

Hazardous Wildlife Zone

Exhibit 2-5: Pearson Field Hazardous Wildlife Zone

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Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit2_5_RK080_PearsonHazard.mxd

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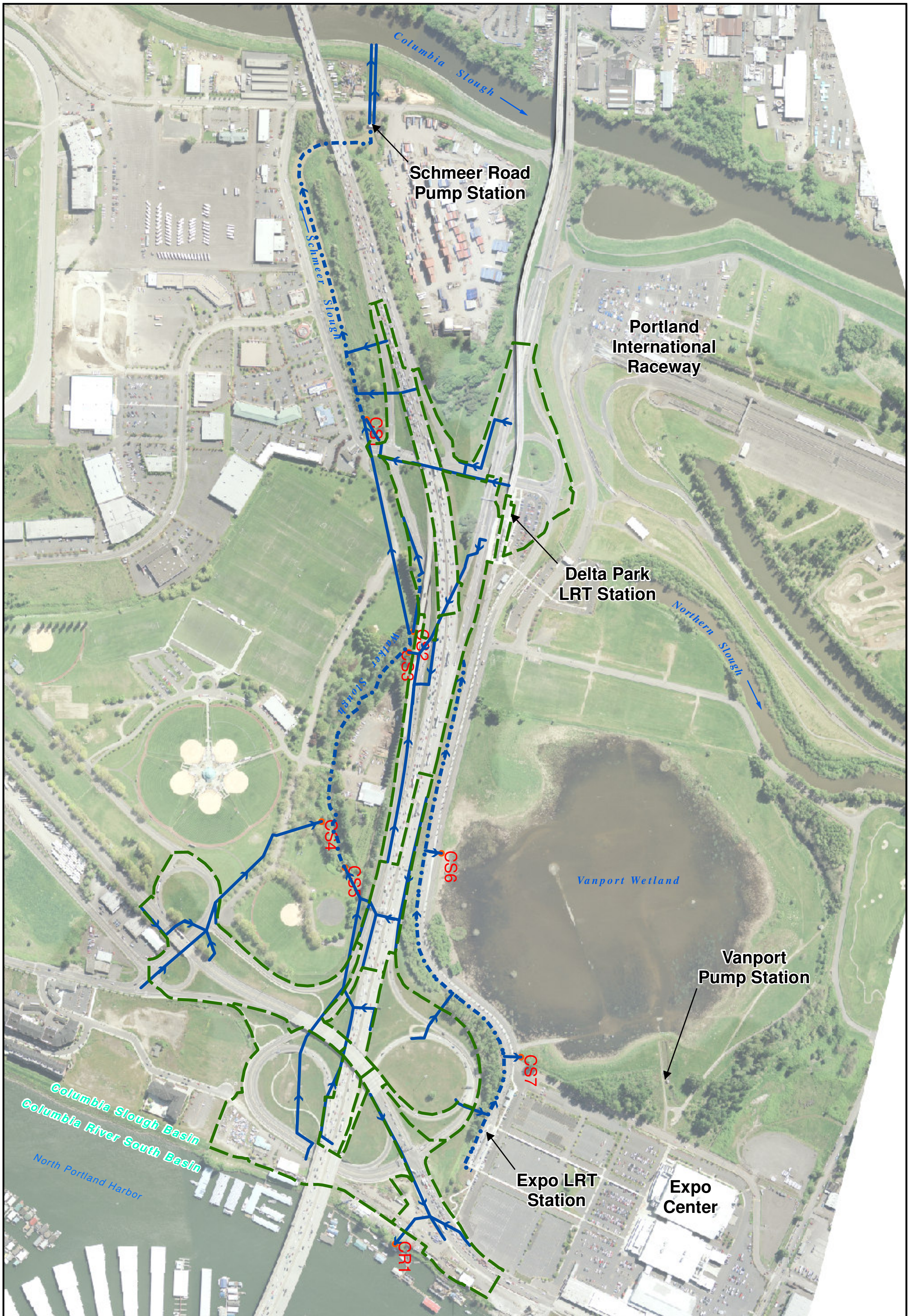

Stormwater Pipe
Drainage Sub-Basin Boundary
Creek, Drainage Channel or Ditch
Drainage Basin Boundary
Outfall

0 250 500
Feet

Exhibit 2-6a: Exisiting Drainage (1 of 4)

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Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit2_6_RK080.mxd

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Stormwater Pipe
Drainage Sub-Basin Boundary
Creek, Drainage Channel or Ditch
Drainage Basin Boundary
Outfall

0 250 500
Feet

Exhibit 2-6b: Exisiting Drainage (2 of 4)

Columbia River CROSSING

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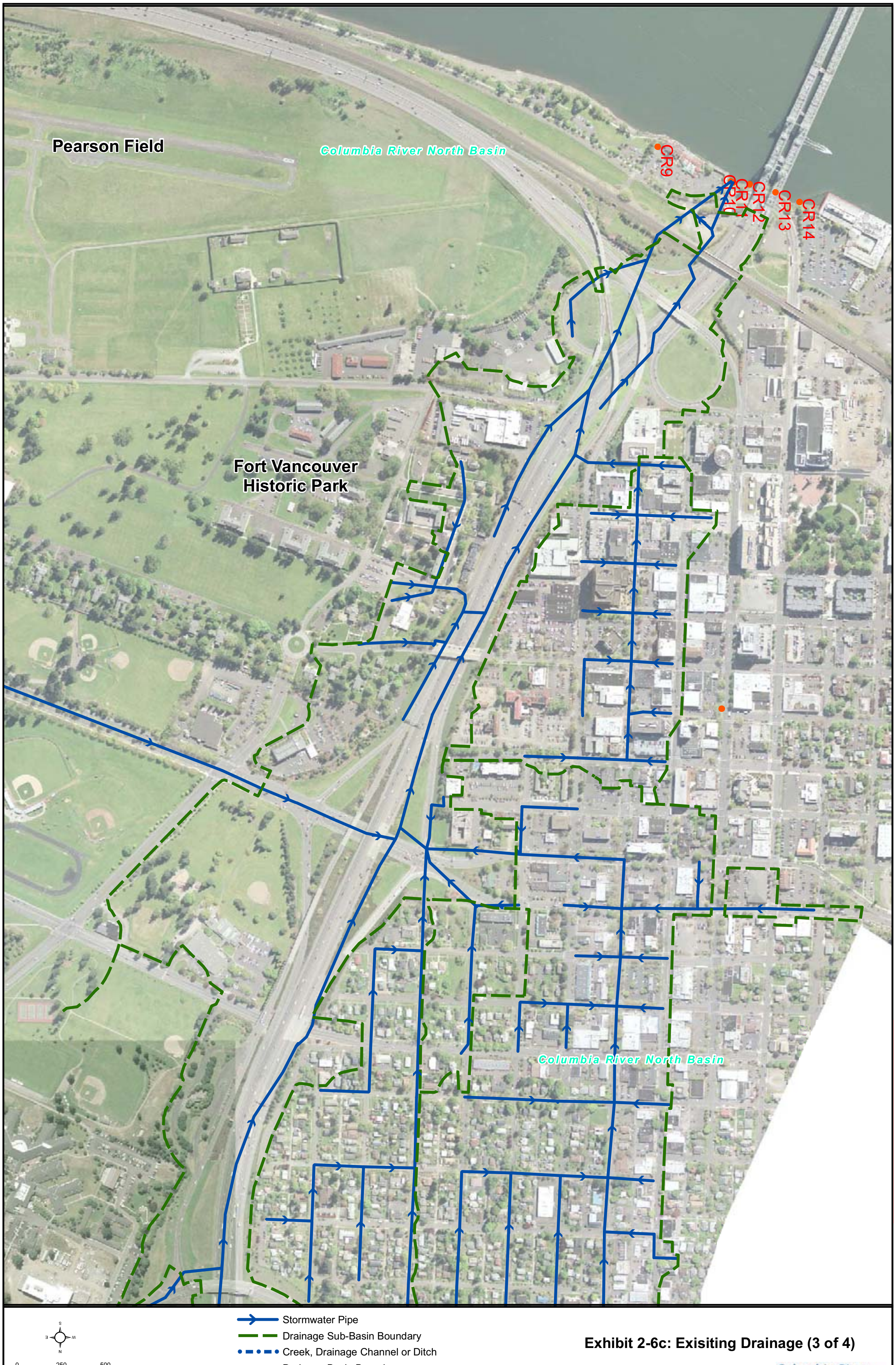

Exhibit 2-6c: Exisiting Drainage (3 of 4)

Columbia River CROSSING

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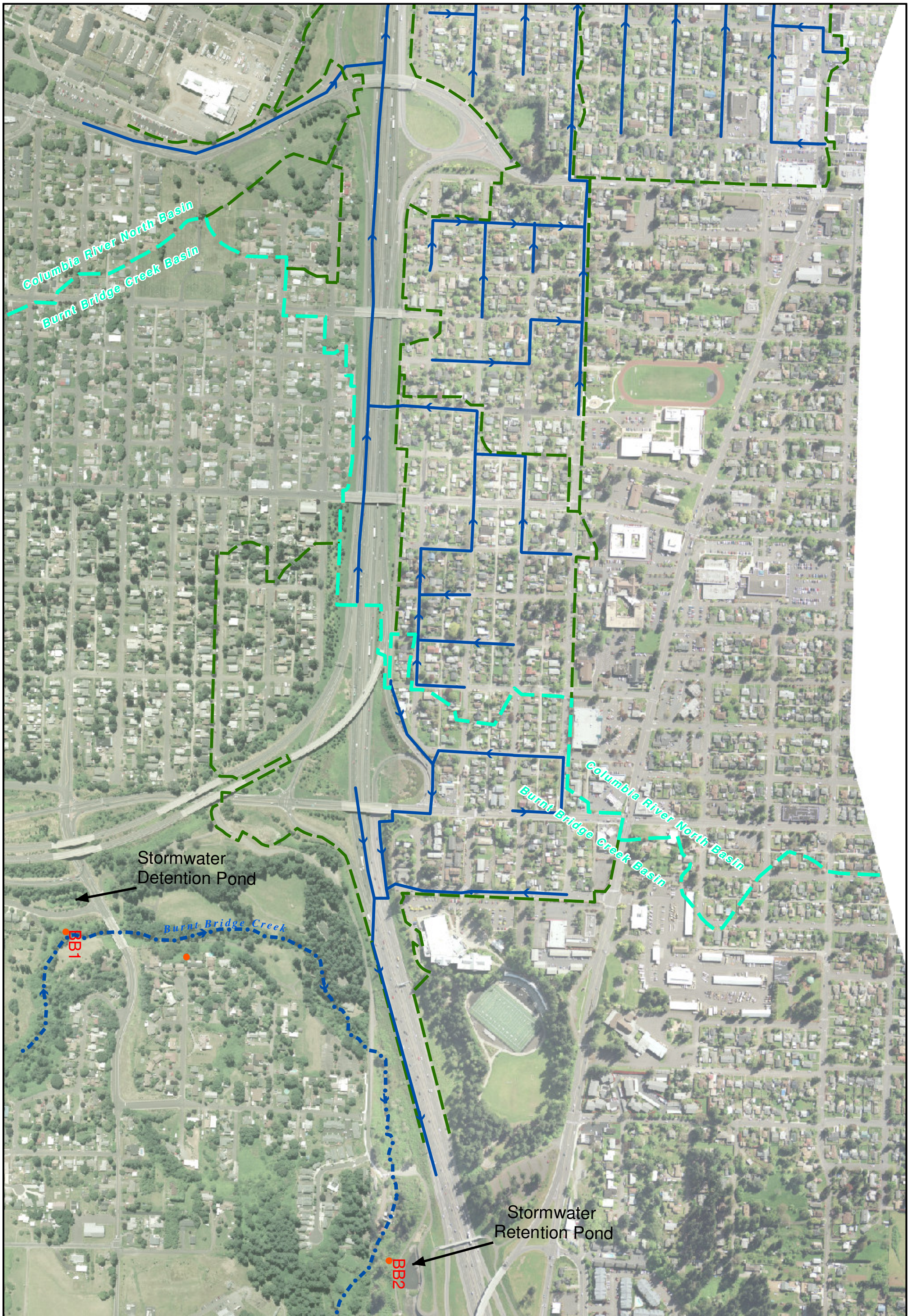

0 250 500
Feet

- Stormwater Pipe
- Drainage Sub-Basin Boundary
- Creek, Drainage Channel or Ditch
- Drainage Basin Boundary
- Outfall

Exhibit 2-6d: Exisiting Drainage (4 of 4)

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit2_6_RK080.mxd

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Drainage from I-5 at and north of the SR 500 interchange area is routed to a retention pond east of I-5 and south of the Main Street interchange. Runoff in this pond usually evaporates or infiltrates, and flows are released to Burnt Bridge Creek only during peak runoff events[10]. Runoff from SR 500 east of I-5 flows to a detention pond located at NE 15th Avenue before being released to Burnt Bridge Creek.

2.6.3 Impervious Areas

Exhibit 2-7 summarizes the areas of impervious street and highway draining to outfalls within or near the project footprint and the level of water quality treatment currently provided. The exhibit includes only impervious areas that might be affected by the project and, as such, does not necessarily reflect the total area draining to individual outfalls. In addition, the areas listed in the exhibit do not include the following roadway surfaces located beneath land-side bridges or highway bridges across North Portland Harbor and Columbia River:

1. Roadway surfaces under existing bridges
   - Columbia Slough Basin – 2.8 acres
   - Columbia River South Basin – 0.4 acres
   - Columbia River North Basin – 4.9 acres
   - Burnt Bridge Creek Basin – 1.7 acres
2. River crossings
   - North Portland Harbor Bridge – 3.8 acres
   - Columbia River Bridges – 8.2 acres

While the areas listed above may be pollution-generating surfaces, they do not contribute to the volume or rate of runoff to outfalls.

As noted on the exhibit, there are approximately 17.6 acres of impervious surface in the Columbia River South Basin for which the method of runoff disposal has not been determined. This area, which is on Hayden Island, comprises about 7.9 and 9.7 acres west and east of the I-5 interchange, respectively.

In summary, the total existing impervious area that might be affected by the project is 204 acres. Runoff from approximately 4 acres (about 2 percent) in the Columbia Slough and 39 acres (about 18 percent) in the Burnt Bridge Creek Basin are treated.

[10] *Stormwater Site Plan, SR 5, Burnt Bridge Creek to N.E. 78th Street.* Prepared by WSDOT SW Region Location Design Office. February 1999.

Exhibit 2-7: Existing Impervious Areas

Project Segment & Outfall	Impervious Area (acres)			Comments
	Untreated	Treatment Provided	Total	
Columbia Slough Basin				
- CS1	-	4.3	4.3	Water quality manhole treats low flows.
- CS2	N/A	N/A	N/A	Flows to outfall not affected by project.
- CS3	6.9	-	6.9	
- CS4	5.4	-	6.0	
- CS5	11.5	-	11.5	Includes existing non-street impervious areas that might be rendered pervious and vegetated.
- CS6	1.5	-	1.5	
- CS7	1.0	-	1.0	Includes Expo LRT platforms
- Other	1.1[1]		1.1	Drains to Portland stormwater system on Marine Drive.
- CR1	4.1	-	4.1	Includes existing non-street impervious areas that might be rendered pervious and vegetated.
- CR2	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR3	0.9	-	0.9	Area that may be affected by project.
Sub-total for Basin	33.0	4.3	37.3	
Columbia River South Basin				
- CR4	1.0	N/A	1.0	Jantzen Drive only.
- CR5	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR6	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR7/8	11.9	-	11.9	
- Other	19.8*	-	19.8	Area that may be affected by project and includes 6 acres for streets and for areas under the HCT guideway.
Sub-total for Basin	32.7	-	32.7	
Columbia River North Basin				
- CR9	4.5	-	4.5	SR 14 drainage system.
- CR10	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR11	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR12	N/A	N/A	N/A	Flows to outfall not affected by project.
- CR13/14	66.0	-	66.0	
- CR15	1.9	-	1.9	
- CR16/17	5.6	-	5.6	
- CR18	2.0	-	2.0	
- CR19	14.6	-	14.6	
Sub-total for Basin	94.6	-	94.6	
Burnt Bridge Creek Basin				
- BB1	-	3.7	3.7	Runoff routed to a detention pond.
- BB2	-	19.0	19.0	Runoff routed to an infiltration pond.
- Other	17.0*	-	17.0	Runoff from WSDOT Maintenance Facility, Main Street and WSDOT parking lot.
Sub-total for Basin	17.0	22.7	39.7	
TOTAL FOR PROJECT	**177**	**27**	**204**	

** Assumed level of water quality treatment.*

3. Stormwater Management

The general approach to stormwater management is to provide the most feasible, practical and cost-effective level of water quality treatment and flow control compatible with regulatory requirements and guidance from agencies such as ODOT, WSDOT and NOAA Fisheries, conditions in the receiving water bodies, available right-of-way, and adjacent land use. Where feasible, treatment is proposed for all new and reconstructed pavement and guideway. In some circumstances, this will not be feasible due to factors such as grade, elevation differences, and availability of locations suitable for water quality and flow control facilities. Runoff from existing retained pavement within the project footprint would be treated only in locations where this is considered practical and cost-effective.

The conceptual design of stormwater management facilities for roadways and Bus Rapid Transit (BRT) will follow the requirements of ODOT, WSDOT, City of Portland and City of Vancouver, as described in the Design Criteria[11]. Unless the buses are electric, BRT vehicles and highway traffic will generate similar pollutants. Runoff from LRT facilities will generally follow the requirements adopted by TriMet, the only LRT agency in the vicinity of the project. TriMet typically designs its stormwater facilities in accordance with the requirements of local jurisdictions or, in their absence, the requirements of ODOT[12].

3.1 Potential Pollutants

While roadway and BRT runoff can convey a number of pollutants, proposed management strategies focus on Total Suspended Solids (TSS), a good surrogate of the general presence of pollutants. Recently, NOAA Fisheries has indicated that dissolved copper is a pollutant of concern for young salmonids. Following is a brief discussion of dissolved copper which may originate from a number of sources such as vehicle brake pads. Although brake pads on light rail vehicles do contain some copper, operators use rheostatic braking to reduce speeds down to 3 mph and disc brakes are not engaged outside the platform area except in an emergency (pers. comm. Lisa Cobb, TriMet. December 26, 2006). As such, LRT runoff is believed to be relatively benign with respect to copper.

While the subject is still a matter for discussion, NOAA Fisheries used a dissolved copper concentration of 5 μg/L as a benchmark when evaluating the Delta Park project. The agency considered concentrations at this level and higher could impair the olfactory senses of young salmonids[13]. For comparison, the acute criteria in Oregon and Washington State for dissolved

[11] *Final Design Criteria Memorandum*. Columbia River Crossing. May 2006.
[12] *Design Criteria*. TriMet. June 2005.
[13] *Endangered Species Act – Section 7 Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, I-5 Delta Park: Victory Boulevard to Lombard Section Project, Columbia Slough, Multnomah County, Oregon*. National Marine Fisheries Service, Northwest Region. November 15, 2006.

copper in freshwater are 4.32 µg/L [14] and 5.5 µg/L[15], respectively, for an assumed hardness of 30 mg/L.

Based on monitoring by WSDOT[16], untreated and treated runoff from high traffic highways with Average Daily Traffic (ADT) greater than 60,000 have expected average dissolved copper concentrations of 14 µg/L and 7.8 µg/L, respectively. Composite sampling data[17] available from WSDOT indicate that there is no meaningful relationship between average daily traffic (ADT) and runoff pollutant concentrations such as dissolved copper (see Exhibit 3-1 for variations in samples taken along I-5). Another evaluation of WSDOT[18] data confirms that there is “no apparent relationship” between ADT and concentrations of dissolved copper.

Exhibit 3-1: Dissolved Copper Concentration in Untreated Runoff from I-5

Mile Post	Traffic Level (ADT)	No. of Samples	Concentration (µg/L)		
			Minimum	Mean	Maximum
96	59,000	18	1.9	4.4	14.0
109	88,000	9	3.8	6.7	12.0
122	117,000	4	1.4	3.4	5.2
185	180,000	7	1.9	5.1	7.0
188	170,000	12	3.3	6.5	18.0

NPDES monitoring by ODOT in 1995 indicates that the mean concentration of dissolved copper in runoff from I-5 in the Portland area is about 8 µg/L, which is similar to measurements by WSDOT.

The subject of dissolved copper, its impact on young salmonids and the contribution from highway projects continues to evolve as evidenced by a two recently-released documents[19 20]. Given the uncertainty regarding requirements for dissolved copper in receiving water bodies, this report does not specifically address the need for treatment to remove this pollutant. The issue will be revisited as more information becomes available.

[14] *Oregon Administrative Rules, Division 41, Table 33B, Water Quality Criteria Summary*. Oregon Department of Environmental Quality. The acute criterion for dissolved copper is $(0.960)*(e^{(0.9422[\ln(hardness)] - 1.700)})$. Note that the criteria on Table 33B have not yet been approved by EPA.
[15] *Water Quality Standards for Surface Waters of the State of Washington Chapter 173-201A WAC*. Washington State Department of Ecology. Publication Number 06-10-091. Amended November 20, 2006. The acute criterion from Table 240(3) for dissolved copper is $(0.960)*(e^{(0.9422[\ln(hardness)] - 1.464)})$.
[16] *BA Writers Guidance for Preparing the Stormwater Section of Biological Assessment*. Washington State Department of Transportation. September 20, 2006. Source of data cited as *2005 NPDES Progress Report for the Cedar-Green, Island-Snohomish, and South Puget Sound Water Quality Management Areas*. Washington State Department of Transportation. September 2005.
[17] *2006 Stormwater Report*. Washington State Department of Transportation. September 2006.
[18] *Phase I: Preliminary Environmental Investigation of Heavy Metals in Highway Runoff*. Michael Barber, Michelle Brown, Katie Lingenfelder, and David Yonge. Washington State Transportation Center, Department of Civil and Environmental Engineering, Washington State University.
[19] *An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity*. Scott Hecht, David Baldwin, Chris Mebane, Tony Hawkes, Sean Gross, Nathaniel Scholz. March 2007.
[20] *Synthesis on the Effects of copper from DOT projects on Salmonid*. William VanPeeters. June 2007.

3.2 Guidelines

The following subsections provide a brief summary of state-specific stormwater management guidelines and project design criteria[21]. Note that the NOAA Fisheries Northwest Region has also issued guidance for staff reviewing projects for ESA compliance[22]. For projects discharging to large water bodies such as the Columbia River, this document recommends that water quality facilities effectively treat 90 to 95 percent of the annual runoff volume.

3.2.1 Oregon

The project design criteria states that drainage in Oregon from I-5 will be handled in accordance with ODOT requirements, and drainage from transit and local roads will be managed in accordance with City of Portland requirements[23].

Based on ODOT guidelines, water quality mitigation will be required for runoff since a) there are local ordinances that require mitigation, b) the projected ADT for I-5 is in excess of 30,000, and c) the increase in impervious area will be greater than 0.25 acres. Following the City of Portland guidelines, flow control will not be required since runoff would be discharged to the Columbia Slough, North Portland Harbor or Columbia River.

The basic goals of ODOT are:

1. Stormwater runoff from a project shall not cause violations of water quality standards in the receiving water.

2. Stormwater runoff from a project shall not cause a net increase in the pollutant load discharged to receiving waters, unless the amount of treatment required is determined to be not practicable.

3. Reduce the pollutant load in stormwater runoff from a project where it can be done within the financial and physical constraints of the project.

Both ODOT and City of Portland criteria are intended to provide removal of 70 percent of the TSS. ODOT requires all water quality facilities be designed to handle runoff from one-third of the two-year, 24-hour storm (0.83 inches) applied to 140 percent of the net-new impervious area[24]. The City of Portland requires stormwater treatment be provided for all new and reconstructed pavement using an equivalent storm depth of 0.83 inches for volume-based facilities (the design pond volume is twice the runoff volume) and, depending on the time of concentration, a storm intensity of between 0.13 and 0.19 inches/hour for flow-based water quality facilities.

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[21] *Final Design Criteria Memorandum*. Columbia River Crossing. May 2006.
[22] *ESA Guidance for Analyzing Stormwater Effects*. NOAA Fisheries Service, Northwest Region. March 2003.
[23] *Stormwater Management Manual*. City of Portland, Bureau of Environmental Services. Revision No. 3, September 2004.
[24] This is defined as the total area of new impervious surface being added to the project minus the total area of existing impervious surface being removed. In order for the existing impervious surface to be considered as removed, it must fully revert to a natural condition; that is, soil amendments are incorporated into subsurface layers, and the area planted with native vegetation (primarily coniferous trees in western Washington and Oregon).

For stormwater disposal, the City's preference is that projects use on-site retention and infiltration to the maximum extent practicable, and projects are required to use the highest of the following categories (Category 1 being the highest) that is technically feasible:

- Category 1 – on-site infiltration with a surface infiltration facility.
- Category 2 – surface infiltration with a public infiltration sump system, private drywell, or soakage trench.
- Category 3 – off-site disposal to a ditch, channel, river, or storm-only pipe system.
- Category 4 – off-site disposal to a combined sewer.

3.2.2 Washington

The Project design criteria states that drainage in Washington State from I-5 will be handled in accordance with WSDOT requirements[25] and drainage from transit and local roads will be managed in accordance with City of Vancouver requirements. The latter agency follows Washington State Department of Ecology (WSDOE) guidelines[26]. Design requirements will be similar since the WSDOT guidelines meet the level of stormwater management established by the WSDOE. Design flows are usually estimated using a continuous simulation hydrologic model such as the WSDOE's *Western Washington Hydrology Model* or WSDOT's *MGS Flood*.

Based on the Highway Runoff Manual and WSDOE guidelines, flow control would not be required for stormwater discharged to the Columbia River. Flow control to reduce runoff to pre-development conditions will, however, be required for discharges to Burnt Bridge Creek.

WSDOT guidelines require water quality treatment for runoff from only the new impervious and converted pervious surfaces if the increase in total impervious area is less than 50 percent. If the increase is 50 percent or greater, treatment is also required for runoff from replaced and retained existing impervious surfaces. Both WSDOT and WSDOE guidelines require basic water quality treatment (sediment reduction) for discharges to the Columbia River; the performance goal is to remove 80 percent of the TSS. In addition, enhanced treatment woulc be required for discharges from I-5 to Burnt Bridge Creek since the ADT exceeds 30,000. WSDOT and FHWA have jointly prepared guidelines[27] that provide an approach for determining stormwater effects. These effects are discussed in the Water Quality and Hydrology Technical Report.

3.3 Best Management Practices

Stormwater Best Management Practices (BMPs) are the physical, structural, and management practices that, when used singly or in combination, prevent or reduce the detrimental impacts of

[25] *Highway Runoff Manual*. Washington State Department of Transportation. Publication Number M 31-16. May 2006.
[26] *Stormwater Management Manual for Western Washington*. Washington State Department of Ecology. Publication Numbers 05-10-029 through 05-10-033. February 2005.
[27] *BA Writers Guidance for Preparing the Stormwater Section of Biological Assessments*. Federal Highways Administration and Washington State Department of Transportation. September 20, 2006.

stormwater, such as the pollution of water, degradation of channels, damage to structures, and flooding[28]. There are the following three groups of BMPs:

- Source control - prevents or reduces the introduction of pollutants to stormwater.
- Flow control - attenuates increased rates of discharge caused by impervious surfaces.
- Runoff treatment - reduces the physical, chemical, and biological pollutant loads.

The following sections discuss general approaches and BMPs for stormwater management.

3.3.1 Temporary Construction Activities

Erosion and sediment control BMPs for construction activities include minimizing vegetation removal, draining runoff away from the top of cut slopes, installing silt fences, ensuring equipment fuel lines and hydraulic hoses are not leaking, locating fuel and chemical storage areas a minimum of 150 feet from water bodies, and temporary settling ponds.

3.3.2 Permanent Facilities

Water quality treatment BMPs include infiltration, dispersion, biofiltration, ponds, and oil control facilities. Flow control BMPs include infiltration, dispersion, and ponds. Source control BMPs for maintenance and operations include street sweeping and spill control.

The project environment is highly urbanized and the available right-of-way is constrained. Options for water quality treatment BMPs and, where required, flow control BMPs are therefore limited. For example, there are only two locations where “ecology embankments” might be considered feasible for water quality treatment; south of Marine Drive and at the Mill Plain interchange. In both locations, however, the 2H:1V embankment side slopes are too steep for this type of application. Water quality BMPs that might be appropriate under such constraints are biofiltration swales, water quality manholes and, where there is adequate right-of-way, wet and dry ponds. Vaults have significant cost and maintenance implications, and would only be considered if there appear to be no other options available.

Biofiltration swales are grass-lined channels that are designed to remove suspended solids from stormwater runoff (see Exhibit 3-2). While vegetated swales are typically classified as providing basic water quality treatment only (reduction in TSS), they may also provide enhanced treatment by removing other pollutants such as nutrients and trace metals through processes such as biological uptake, sorption and ion exchange[29].

Water quality manholes[30] are not frequently employed on highway projects because of high maintenance requirements. They are, however, used by TriMet on its transit projects, and by cities on urban roads and streets. These include oil control manholes, sediment removal manholes, and manufactured treatment technologies. While the City of Portland may, through its

[28] *Highway Runoff Manual, M31-16*. Washington State Department of Transportation, Environmental and Engineering Programs. May 2006.
[29] *Highway Runoff Manual*. Washington State Department of Transportation. Publication Number M 31-16. May 2006.
[30] These are proprietary systems that may also be referred to as “manufactured treatment technology” and “media filters.”

Vendor Submission Guidance, accept manufactured systems as providing enhanced treatment, those systems approved by WSDOE have been approved for basic treatment only.

Wet and dry ponds are generally considered to provide basic or enhanced treatment (for example metals reduction) depending on the design. When appropriately sized, they can also provide flow control. Wet and dry ponds typically have a two-cell arrangement with the first cell providing a reduction in TSS through sedimentation. Wet ponds have a permanent pool of water and vegetated wet ponds, or constructed stormwater treatment wetlands, provide enhanced treatment through the biological action of emergent aquatic vegetation (see Exhibit 3-3). Dry ponds do not have a permanent pool of water in the second cell – they are designed to drain or infiltrate and to remain dry between storm events. See Exhibit 3-4 for a typical infiltration pond.

Note that Exhibits 3-2, 3-3 and 3-4 show typical WSDOT details and that specific requirements such as topsoil depth for a biofiltration swale may vary depending on the agency.

3.4 Other Considerations

3.4.1 Infiltration

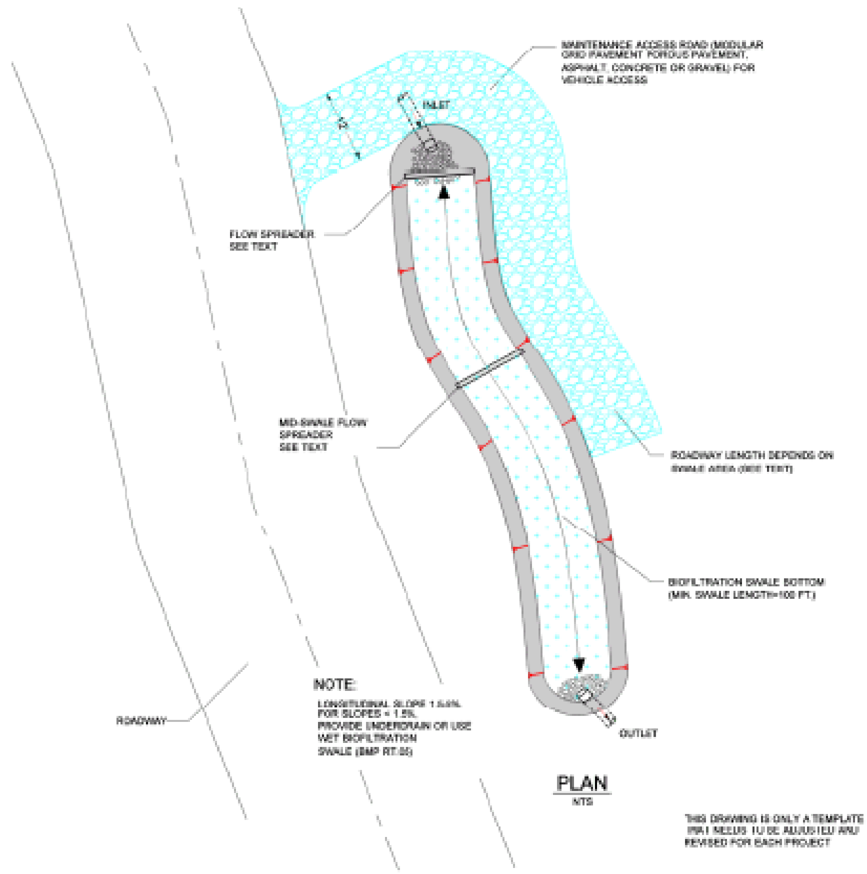
As described in Section 2.3, the soils in the API south of North Portland Harbor are in Hydrologic Group D and, as such, are not suitable for infiltration due to a slow infiltration rate and high groundwater table.

Hydrologic Group A soils may be found within the API on Hayden Island, and Group B soils are prevalent north of the Columbia River. On-site infiltration could be feasible if adequate room exists within the right-of-way and other factors such as land use or the presence of a high groundwater table or contaminated soils do not preclude this approach. While such soils may be potential candidates for stormwater infiltration, the suitability of specific sites and design parameters will need to be verified by site investigations. Local jurisdictions may also need to be consulted where potential sites lie above a sensitive groundwater zone and for the applicable level of pre-treatment. For these reasons, infiltration is <u>not</u> considered in this report as a method of runoff disposal. This assumption will be reassessed as the project advances and additional data become available.

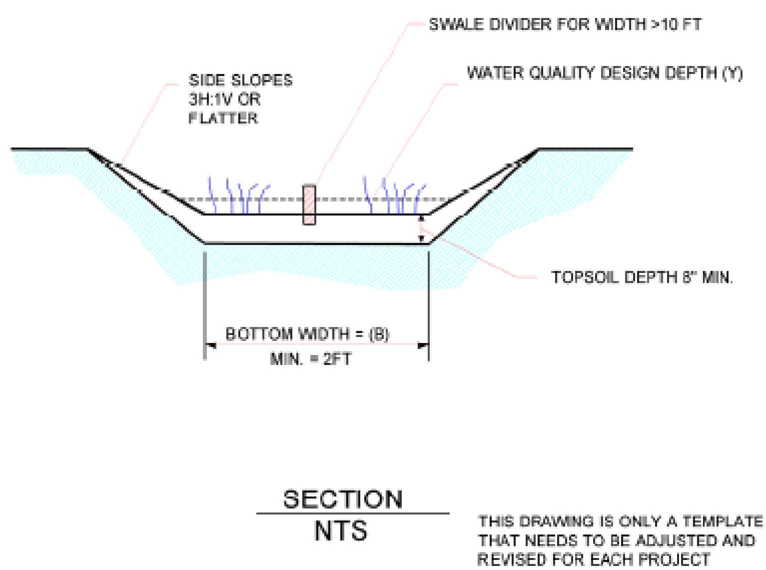
3.4.2 Aquifer Protection

As discussed in Section 2.4, the EPA recently designated the Troutdale Aquifer as a Sole Source Aquifer. Under this designation, proposed federal financially-assisted projects that have the potential to contaminate the aquifer are subject to EPA review. In addition, the City of Vancouver has designed the entire community as a Critical Aquifer Recharge Area and established Special Protection Zones around its wellheads. These designations prohibit certain activities that could result in aquifer contamination, none of which are believed to apply to this project.

Groundwater contamination from the project is not expected to be an issue given the depth to the aquifer – water supply wells in this area are typically completed at an <u>elevation</u> of less than 20 feet.



BIOFILTRATION SWALE SCHEMATIC



BIOFILTRATION SWALE CROSS-SECTIONS

Exhibit 3-2: Biofiltration Swale

Columbia River CROSSING

Sources: *Highway Runoff Manual M 31-16* (http://www.wsdot.wa.gov/fasc/EngineeringPublications/library.htm)

Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit3_2_SwalesDigrm_RK080.mxd

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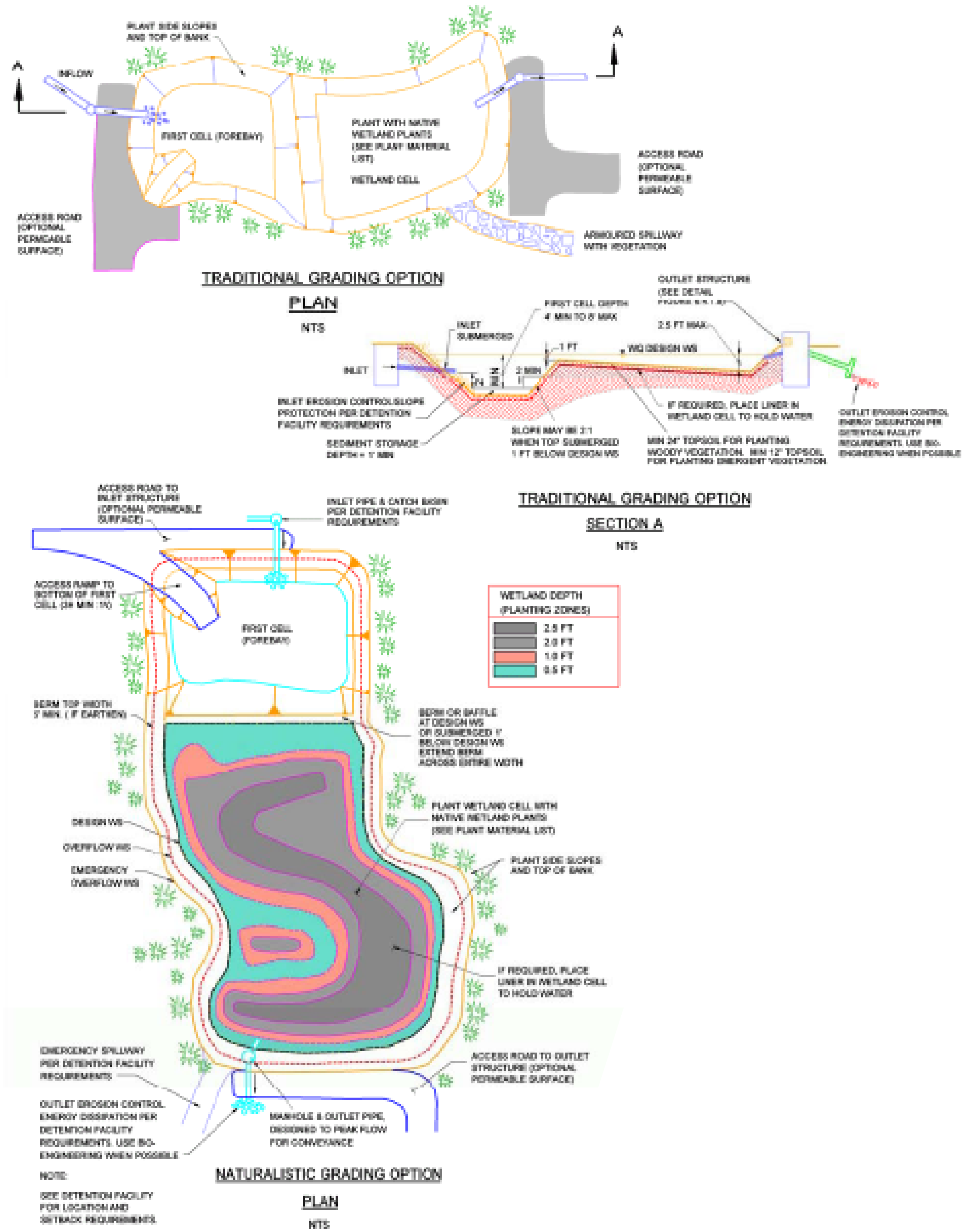

Exhibit 3-3: Vegetated Wet Pond

Columbia River CROSSING

Sources: *Highway Runoff Manual M 31-16* (http://www.wsdot.wa.gov/fasc/EngineeringPublications/library.htm)

Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit3_3_WetPond_RK080.mxd

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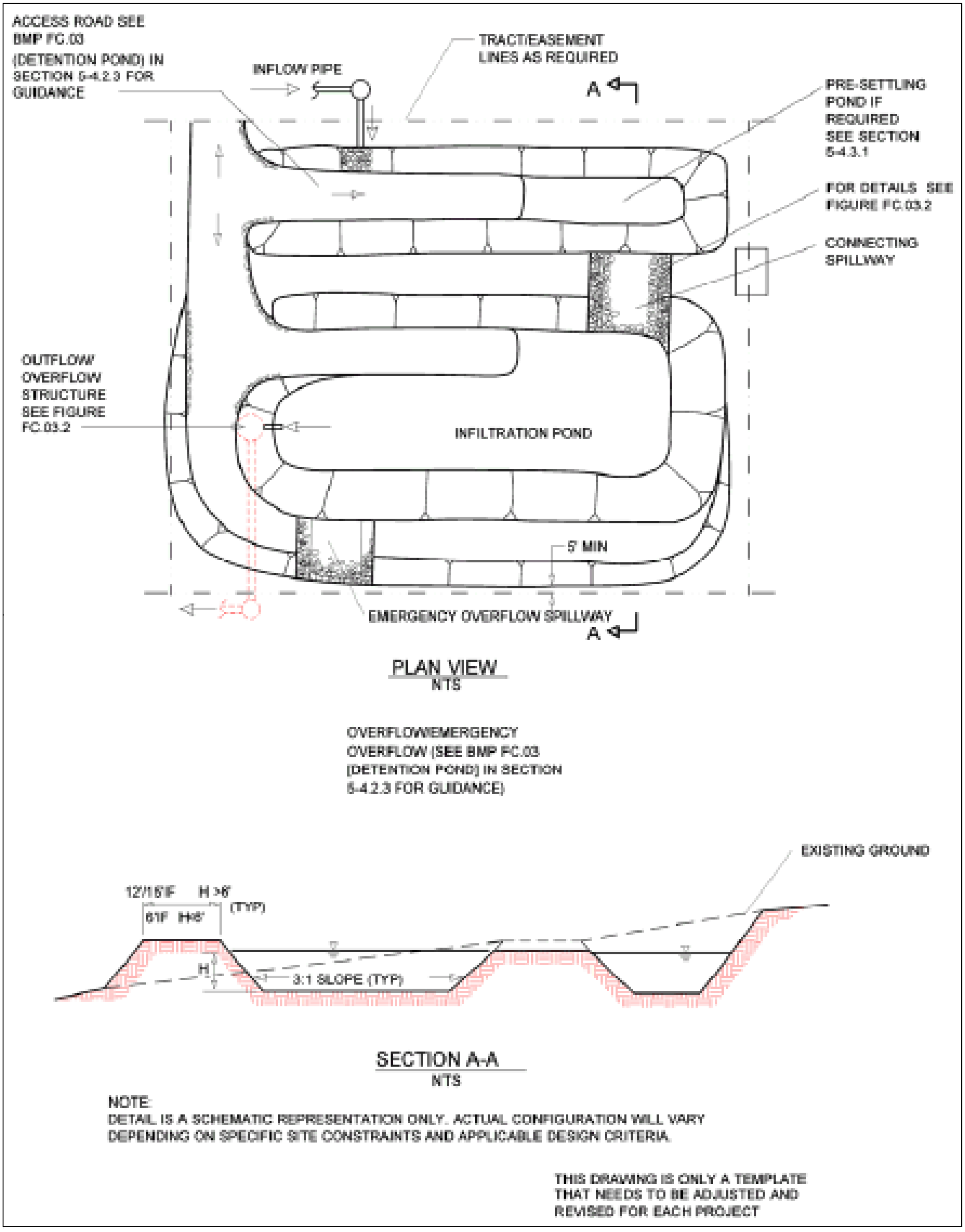

Exhibit 3-4: Infiltration Pond

Sources: *Highway Runoff Manual M 31-16* (http://www.wsdot.wa.gov/fasc/EngineeringPublications/library.htm)

Analysis by J. Koloszar; Analysis Date: 9/24/07; Plot Date: 9/24/07; File Name: Exhibit3_3_WetPond_RK080.mxd

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3.4.3 Airspace Related Restrictions

Airspace issues are briefly described in Section 2.5 and a more in-depth discussion may be found in the Aviation Technical Report[31]. An Advisory Circular[32] issued by the FAA provides guidance on land uses that have the potential to attract hazardous wildlife on or near public-use airports. Semi-permanent or permanent ponds and wetlands within this exclusion zone are strongly discouraged by the FAA unless they are designed and operated to ensure that standing water is continuously present for no more than 48 hours, and the facility is dry between storm events. If these constraints cannot be achieved, the FAA recommends that facility be placed underground or physical barriers such as netting used to prevent access by birds.

3.4.4 Landfills

The only known landfill within the project footprint is located on Hayden Island[33]. Based on available data, a seven to eight-foot layer of clean fill was placed over this site when it was closed in 1970. The landfill, which was unregulated, occupied about 20 acres and is located west of the existing highway and north of Hayden Island Drive. The area is not recommended for stormwater facilities, especially ponds and swales, due to the presence of groundwater contaminants.

3.4.5 Utilities

A separate report[34] presents utility impacts and based on the information presented, conflicts between existing utilities and proposed stormwater facilities are expected to be few in number. Where appropriate, utilities would be mapped during final design to determine exact location and profile. This data would enable designers to consider them when determining the grades and location of stormwater infrastructure, especially the conveyance systems.

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[31] *Interstate 5 Columbia River Crossing, Aviation Technical Report*. Columbia River Crossing. July 2007.
[32] *Hazardous Wildlife Attractants on or near Airports, Advisory Circular 150/5200-33A*. U.S. Department of Transportation, Federal Aviation Administration. July 27, 2004
[33] Site ID 77 and 1559 on website http://www.deq.state.or.us/lq/ecsi/ecsi.htm. Accessed in July 2007.
[34] *Utilities: Relocation Strategy*. Draft report. Columbia River Crossing. January 2007.

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4. Developed Conditions

This section presents the conceptual approaches proposed for stormwater runoff management during construction and for post-construction conditions. As discussed in Section 3, the approaches used are based on manuals developed to address the adverse impact of projects on water bodies. Potential impacts could result from construction activities, design and operations. Since there are no jurisdictional flow control requirements for Columbia Slough, North Portland Harbor, and Columbia River, the primary impacts of concern are those that could affect water quality. Again, only stormwater discharges to Burnt Bridge Creek would require flow control.

For discussion purposes, the project corridor has been divided into four main segments or drainage basins as follows:

1. *Columbia Slough Basin* – between Victory Boulevard and the crests of the North Portland Harbor bridges.
2. *Columbia River South Basin* – between the crests of the North Portland Harbor and Columbia River Bridges.
3. *Columbia River North Basin* – from the crest of the Columbia River Bridges to the Columbia River/Burnt Bridge Creek watershed divide near the SR 500 interchange.
4. *Burnt Bridge Creek Basin* – from the SR 500 interchange north.

Although the high point or crest of the Columbia River Bridges may not coincide with the State line, it is assumed that all runoff north of the crest will be handled in accordance with Washington State requirements and runoff to the south will be handled in accordance with Oregon standards.

4.1 Highway and Transit Alternatives

The Draft Environmental Impact Statement (DEIS) is considering the following five alternatives:

- **Alternative 1**

  This is the “no build” scenario.

- **Alternatives 2 & 3**

  The only significant difference between these two alternatives is that the high capacity transit (HCT) transit mode for Alternatives 2 and 3 are BRT and LRT, respectively. These alternatives would include new bridges across North Portland Harbor and Columbia River to carry an exclusive transit guideway as well as northbound and southbound I-5 traffic; the existing I-5 bridges across North Portland Harbor and Columbia River would be removed. Both alternatives include two optional alignments for the new Columbia River Bridges, one downstream and one upstream of the existing crossing.

I-5 would stay close to its existing alignment, and highway construction would include interchange reconfigurations to improve safety and traffic flow. Both HCT modes would start at TriMet's Expo LRT station in Oregon. North of the Columbia River, the HCT guideway would serve downtown Vancouver from stations located on Washington Street before turning east onto McLoughlin Boulevard to a Park and Ride facility at Clark College. HCT would then run north, parallel to and west of I-5, terminating at a multistory Park and Ride facility at Kiggins Bowl. This is referred to as the *I-5 Alignment*.

- **Alternatives 4 & 5**

  Again, the only difference between these two alternatives is that Alternative 4 has BRT as the transit mode while LRT is the mode for Alternative 5. The existing I-5 bridges across the Columbia River would be retained and a new supplemental bridge constructed across the Columbia River. The new bridge would be located downstream of the existing crossings, and would carry southbound I-5 traffic and an exclusive HCT guideway. The existing bridges would carry northbound I-5 traffic, and a new pedestrian and bicycle path would be constructed on the upstream spans.

  Like Alternatives 2 & 3, I-5 would stay close to its existing alignment, and highway construction would include interchange reconfigurations and safety improvements. Both transit modes would start at TriMet's Expo LRT station. North of the Columbia River, HCT guideway would serve downtown Vancouver from stations located on Washington Street before continuing north along Broadway Street and then Main Street to a surface Park and Ride facility at an existing WSDOT maintenance facility in the Lincoln neighborhood. This is referred to as the *Vancouver Alignment*.

Even though the I-5 alignment is presented with Alternatives 2 & 3 and the Vancouver Alignment with Alternatives 4 & 5, both could actually be constructed with any alternative.

There are a number of optional routes currently being considered for HCT routes through Vancouver within each alternative. These routes follow alignments that are different from those shown in this report. From a drainage perspective, the runoff management strategies will be similar regardless of the route selected for Vancouver and, as such, are not discussed separately.

4.2 Temporary Construction Activities

Without proper management, construction activities could adversely affect water quality in receiving water bodies. Adverse impacts could result in the erosion of disturbed areas, and the accidental release of fuels and soluble or water-transportable construction materials.

Exhibit 4-1 summarizes the areas that could be disturbed during construction. The exhibit includes all areas within the rights-of-way proposed for the project but does not include potential areas of construction in or over water or additional land that could be required outside the rights-of way for staging or laydown. While potential staging and laydown sites have been identified, the project is not at the level of design development where such areas can be quantified. In addition, such locations and areas are directly dependent on a contractor's work site organization and construction methods. As expected, there is little difference in area – the spread between the highest and lowest total area is only three percent.

NPDES Construction Stormwater Discharge Permits will regulate the discharge of stormwater from construction sites. These permits include discharge water quality standards, runoff monitoring requirements, and provision for preparing a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP contains all the elements of a Temporary Erosion and Sediment Plan and Spill Prevention Control and Countermeasures Plan.

Exhibit 4-1: Areas of Potential Disturbance during Construction

Project Segment	Alternatives 2 & 3		Alternatives 4 & 5
	Downstream River Crossing	Upstream River Crossing	
Roadways			
• Columbia Slough Basin	84 acres	84 acres	77 acres
• Columbia River South Basin	42 acres	40 acres	43 acres
• Columbia River North Basin	130 acres	129 acres	126 acres
• Burnt Bridge Creek Basin	71 acres	71 acres	70 acres
Sub-total	**327 acres**	**324 acres**	**316 acres**
Transit *			
• Columbia Slough Basin	1 acre	1 acre	1 acre
• Columbia River South Basin	4 acres	4 acres	4 acres
• Columbia River North Basin	25 acres	25 acres	22 acres
• Burnt Bridge Creek Basin	8 acres	8 acres	30 acres
Sub-total	**38 acres**	**38 acres**	**57 acres**
TOTAL	**365 acres**	**362 acres**	**373 acres**

** The difference in area between LRT and BRT are not considered significant at this level of analysis.*

The SWPPP and its adoption by construction personnel are essential for ensuring water quality standards are met during construction, and a single, comprehensive plan would ensure project-wide consistency. An SWPPP typically contains the following elements:

1. Project information
2. Existing site conditions.
3. Potential erosion problem areas.
4. Descriptions and drawings of pollution-prevention measures and BMPs for:
    - Preserving vegetation
    - Construction Access
    - Flow control
    - Sediment controls
    - Soil stabilization
    - Slope protection
    - Existing drain inlet protection
    - Channel and outlet stabilization
    - Pollution control (including spill prevention)
    - Dewatering control
    - BMP maintenance, inspection and monitoring
5. Construction phasing and implementation schedule for BMPs.

6. Compliance assurance procedures and corrective actions in case performance goals are not achieved.
7. Spill response procedures
8. Engineering calculations.

Water quality standards, which include turbidity and pH, are usually monitored at the point(s) of discharge. There may also be special requirements in addition to turbidity and pH for discharges to Columbia Slough and Burnt Bridge Creek, both of which are 303(d) listed watercourses.

The selection of construction BMPs is dependent on the specific site layout and sequence of construction activities and, as such, is beyond the scope of this report.

4.3 Permanent Facilities

For all alternatives, gravity pipe drainage systems are proposed to collect and convey runoff from the new guideway, pavement, ramps and associated road and transit improvements. Basic treatment to reduce TSS would be provided to the maximum feasible extent. Due to differing ownership and responsibility for maintenance, roadway and transit runoff would be directed to separate water quality facilities.

This report does not specifically address enhanced treatment to reduce the presence of dissolved metals in runoff. Design work has not progressed to the level where it can be determined whether there is adequate room for vegetated wet ponds at potential locations. These locations are at the Marine Drive and SR 14 interchanges.

Long-term increases in stormwater pollutants from highways and streets are usually a result of permanent changes in impervious area, design of the stormwater drainage systems, and increased vehicular traffic (including HCT).

Note that the strategies presented in this report represent only one set of general approaches for handling and treating stormwater runoff, and will likely be modified as the project progresses. In addition, the exhibits show possible locations for water quality facilities; the actual locations will depend, to a large degree, on still-to-be-developed interchange grading plans.

4.3.1 Preliminary Design Assumptions

For the purposes of conceptual design, it has been assumed that biofiltration swales would be the BMP of choice for water quality treatment. This approach is consistent with the adjacent Delta Park Project. As noted above, the design has not progressed to the level of detail where location of stormwater infrastructure can be determined with high degree of certainty and the locations shown on exhibits are conceptual only. While it is feasible to estimate impervious areas and identify general sites for water quality facilities, it is not practical to determine specific design constraints such as the longitudinal gradient for swales, and conditions for growth and survival of vegetation (for example, the impact of overhead structures on sunlight availability).

In lieu of detailed site information, the following basic assumptions were made when calculating the general size of swales:

- Longitudinal gradient of two percent and side slopes of 4H:1V.
- Maximum depth of water quality flow of four inches and a Manning's "n" of 0.35. The latter value assumes that artificial roughness is created in the bottom of the swale.
- Maximum bottom width of 25 feet.

One significant result of these design assumptions is that the length of swales would not exceed about 140 to 150 feet, depending on bottom width, for a minimum residence time of nine minutes.

While existing stormwater conveyance systems that would be used by the project are assumed to have adequate capacity to handle any increase in flows, such capacity will need to be verified.

4.3.2 Columbia Slough Basin

Exhibits 4-2a and 4-2b show the water quality elements of the proposed stormwater management system in the Columbia Slough Basin for Alternatives 2 & 3 and 4 & 5, respectively. The interchange and transit layouts are similar for Alternatives 2 & 3 regardless whether the Columbia River Bridges have a downstream or upstream alignment.

The total new and reconstructed impervious area draining to or within this basin from roadways and HCT guideway is about 55.7 and 54.6 acres for Alternative 2 and 3, respectively. These areas include the I-5 mainline and HCT guideway between North Portland Harbor and the high point of the Columbia River Bridges that would naturally drain to the Marine Drive interchange. They do not include land that might be acquired for the project that is currently impervious – whether such land would be converted to pre-development (pervious) conditions is not known at this time. The areas assume a downstream alignment for the Columbia River Bridges; they should be decreased by approximately 0.5 acres for the upstream alignment.

The equivalent areas are about 45.8 and 44.7 acres for Alternative 4 and 5, respectively. They include the HCT guideway between North Portland Harbor and the high point of the Columbia River Bridge as well as a portion of the southbound I-5 lanes on the Columbia River Bridge.

The difference in area of about 1.1 acres between Alternative 2 and 3, and between Alternative 4 and 5 reflect the additional area required for a BRT transfer facility at the Expo Station.

Conveying runoff from the I-5 mainline and HCT guideway north of the North Portland Harbor to the Marine Drive interchange area would technically result in an inter-basin transfer since Columbia Slough flows into the Willamette River. The Willamette River joins the Columbia River a short distance downstream. Handling runoff at the Marine Drive interchange has several advantages including:

- The Marine Drive interchange is the only area south of the Columbia River where there is a significant area available for water quality facilities.
- The number of swales is reduced for Hayden Island where available space is limited and a closed landfill has contaminated the groundwater (see section 4.3.3). In addition, the sands may be too "clean" to provide the adequate water quality treatment.

4.3.2.1 Roadways

The general approach used for stormwater treatment is to convey, to the maximum practical extent, runoff from new and reconstructed impervious roadway surfaces to water quality facilities located at the Marine Drive interchange. The interchange footprint provides the only significant area available for such facilities within the proposed project right-of-way south of North Portland Harbor. This approach would be the same for all build alternatives.

Based on current layouts, approximately 1,600 feet of the existing I-5 pavement immediately north of the Victory Boulevard over-crossing would not need rebuilding. It is proposed that the existing ODOT drainage systems in this area for I-5, Victory Boulevard and associated ramps, and Denver Avenue underpass be retained. The Victory Boulevard drainage system, which discharges to outfall CS1, has a water quality manhole that provides sediment reduction at low flows. There is no treatment of runoff from the Denver Avenue underpass and I-5 mainline before it is discharged into the Peninsula Drainage District No.2 surface water system at outfalls CS2 and CS3. There is not sufficient room to provide a water quality facility for either outfall due their close proximity to the ramp from Victory Boulevard to northbound I-5. Retaining the existing drainage system would result in runoff from about 1.9 acres of reconstructed I-5 pavement, which drains to outfall CS3, not being treated.

Based on the proposed vertical profile for I-5, runoff from the mainline would naturally flow (as it presently does) towards a low point immediately south of the Marine Drive interchange. The reconfigured Marine Drive interchange offers an opportunity to provide water quality facilities sized to handle runoff to this low point as well as all but one ramp and most of the reconfigured Marine Drive. Runoff originating on the east side of the highway could be directed to one of two biofiltration swales located south of Marine Drive before being discharged to outfall CS4 via 24-inch diameter City of Portland stormwater pipes. Runoff from I-5 and portions of the ramps south of Marine Drive could be treated by swales located in the in-field area immediately east of I-5 and south of Marine Drive. Swales in this area would also handle runoff from ramps and portions of Marine Drive east of the highway. Outflows from these swales would be discharged to the Vanport Wetland pump station via outfall CS7 or to Walker Slough via outfall CS5. While less cost-effective, Walker Slough is the preferred point of discharge as it presently receives most of the runoff from I-5 and the Marine Drive interchange area.

There are three areas, however, where it is not practical to convey runoff to the Marine Drive interchange. They are:

- A portion of the off-ramp from Marine Drive to southbound I-5 that slopes south towards Victory Boulevard bridge.
- Marine Drive west of the HCT guideway that slopes west towards the Expo Center.
- The Marine Drive Connector, a new road located east of the Marine Drive interchange.

Runoff from the off-ramp from Marine Drive to southbound I-5 that slopes south towards Victory Boulevard over-crossing (about 1.5 acres) would be drained to outfall CS1 on Schmeer Slough via the City of Portland stormwater system on Victory Boulevard. The water quality manhole near the outfall would be enlarged to handle any increase in runoff.

Runoff from the reconstructed Marine Drive pavement west of the HCT crossing (about 2.3 acres) would be conveyed, as is currently the case, to an existing stormwater system immediately adjacent to the Expo Center. This system discharges to North Portland Harbor via outfall CR3.

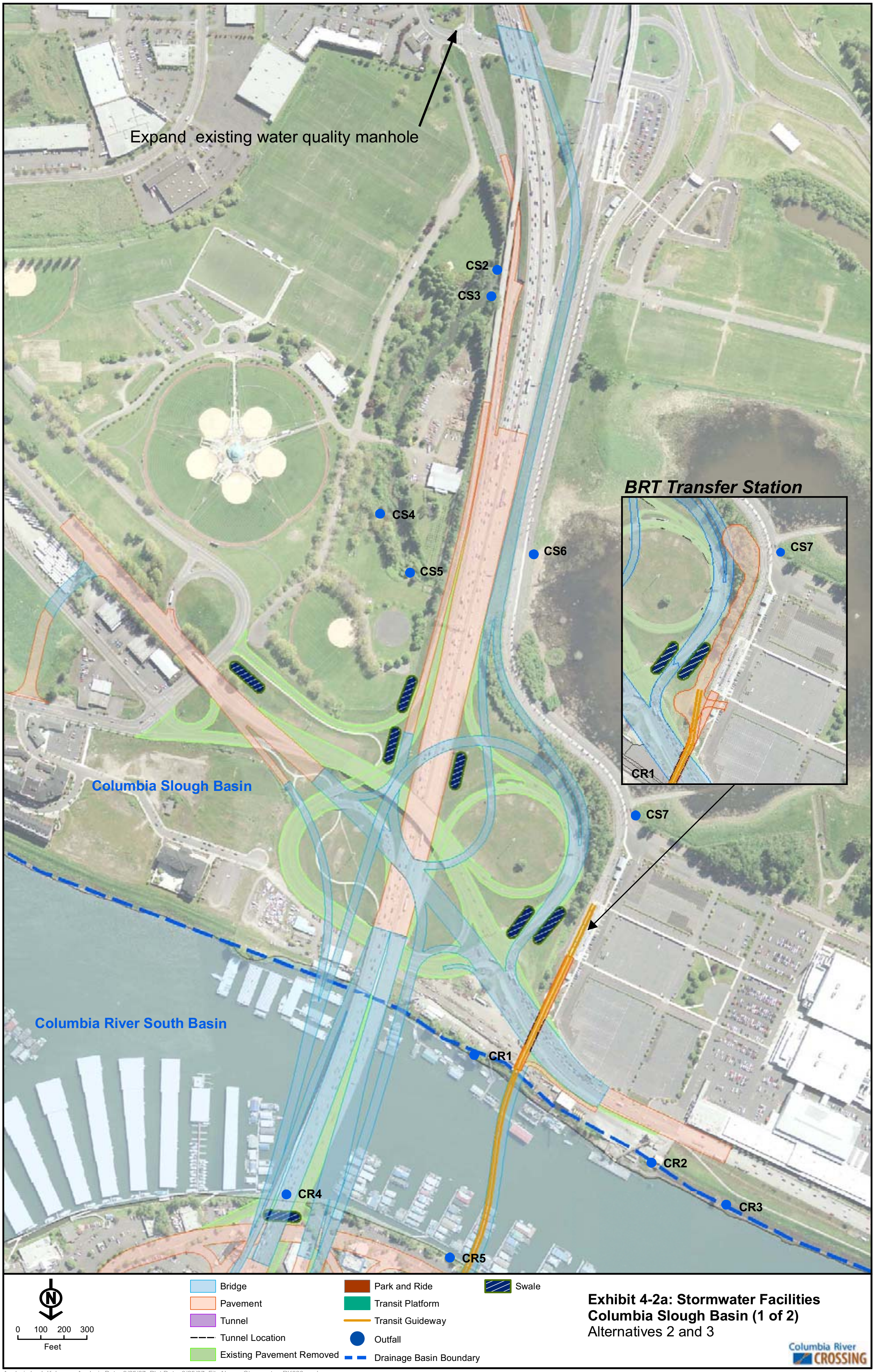

Exhibit 4-2a: Stormwater Facilities
Columbia Slough Basin (1 of 2)
Alternatives 2 and 3

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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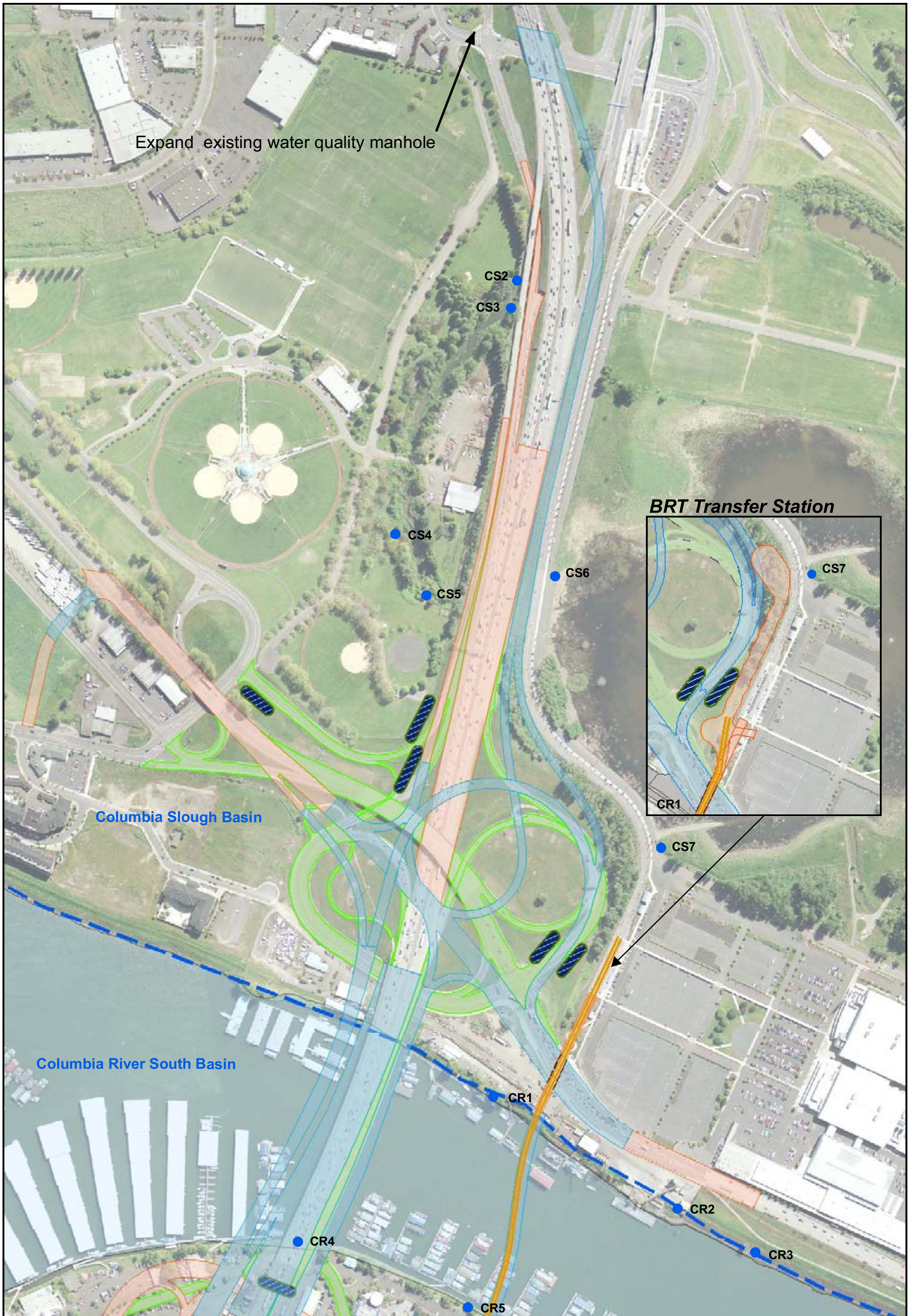

N
0 100 200 300
Feet

Bridge
Pavement
Tunnel
Tunnel Location
Existing Pavement Removed
Park and Ride
Transit Platform
Transit Guideway
Outfall
Drainage Basin Boundary
Swale

Exhibit 4-2b: Stormwater Facilities
Columbia Slough Basin (2 of 2)
Alternatives 4 and 5

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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Runoff from the Marine Drive Connector (about 0.7 acres) would be discharged to the 27-inch diameter City of Portland stormwater pipe on Anchor Way.

4.3.2.2 Transit

The proposed guideway vertical profile is such that runoff between the Expo Station and crest of the Columbia River Bridge for Alternatives 2 & 3 could be conveyed to the Expo Station area. For Alternatives 4 & 5, the transit and southbound highway occupy the same structure across the Columbia River and an opportunity exists for runoff from part of the highway component of the bridge (about 4.6 acres) to be conveyed to the Expo Station, further reducing stormwater management requirements on Hayden Island.

Biofiltration swales would be provided adjacent to the HCT guideway south of Marine Drive and flows could be discharged via outfall CS7.

4.3.2.3 Water Quality Facilities

The following exhibit lists the proposed water quality swales shown on Exhibits 4-2a and 4-2b.

Exhibit 4-3: Water Quality Facilities – Marine Drive Interchange

Mode	Impervious Area (acres)	Proposed Water Quality Swales*	Outlet	Comments
Alternatives 2 & 3				
Highway	5.8	N/A	CS-1	Existing water quality manhole on Victory Boulevard expanded.
Highway	5.8	1 – 25’ x 110’	CS-4	Serves Marine Drive and ramps north of Marine Drive.
Highway	34.2	3 – 25’ x 140’	CS-5	Serves I-5 south of the crest of the Columbia River Bridges and ramps south of Marine Drive.
Highway	3.0	1 – 25’ x 100’	CS-5	Serves Marine Drive and some ramps west of I-5.
Transit	7.2	1 – 25’ x 120’	CS-7	Serves guideway south of the crest of the Columbia River Bridge.
Alternatives 4 & 5				
Highway	5.8	N/A	CS-1	Existing water quality manhole on Victory Boulevard expanded.
Highway	9.4	1 – 25’ x 130’	CS-4	Serves Marine Drive and ramps north of Marine Drive.
Highway	15.8	2 – 25’ x 125’	CS-5	Serves I-5 south of crest of North Portland Harbor Bridge and ramps south of Marine Drive.
Highway	3.7	1 – 25’ x 100’	CS-5	Serves Marine Drive and some ramps west of I-5.
Transit	11.4	1 – 25’ x 140’	CS-7	Serves guideway south of the crest of the Columbia River Bridge. Includes 4.6 acres of southbound lanes on Columbia River Bridge.

** The dimensions shown are for the swale invert.*

If a wet/dry pond is provided for runoff from I-5 mainline and ramps south of Marine Drive, a storage volume of approximately 9.5 acre-feet and 4.4 acre-feet would be required for Alternatives 2 & 3 (34.2 acre impervious area) and Alternatives 4 & 5 (15.8 acre impervious area), respectively.

4.3.3 Columbia River South Basin (Hayden Island)

Exhibits 4-4a, 4-4b and 4-4c present the major elements of the proposed stormwater management system in the Columbia River South Basin. In this area, there are significant differences between interchange and transit layouts for Alternative 2 and 3 depending on whether the Columbia River bridges have a downstream (Exhibit 4-3a) or upstream (Exhibit 4-3ba) alignment. There are also significant differences between the replacement and supplemental Columbia River Bridge alternatives as shown on the exhibits.

The total new and reconstructed impervious area draining to or within this basin from roadways is about 19.6 acres for Alternatives 2 & 3 and about 28.2 acres for Alternatives 4 & 5. The main reason for the difference in area is that all the I-5 mainline runoff can be conveyed to the Marine Drive interchange for Alternatives 2 & 3 compared with only a portion of the southbound lanes for Alternatives 4 & 5. For Alternatives 2 & 3, there is no appreciable difference between the impervious areas for a downstream and upstream alignment. As described in Section 4.3.2, runoff from the HCT guideway and part or all of the I-5 mainline would be conveyed to the Marine Drive Interchange area.

The groundwater table on Hayden Island is expected to be at a depth of between 20 and 25 feet[35]. Data from five of six boreholes drilled in the vicinity of the interchange indicate that the groundwater surface fluctuates from about elevation nine feet to elevation 14 feet; a groundwater surface elevation of about 18 feet was recorded in the sixth well.

4.3.3.1 Roadways

Regardless of the alternative, the Hayden Island interchange layout is such that it will not be practical or cost-effective to direct runoff from ramps to a single area within the interchange area for water quality treatment. To the maximum feasible extent, runoff would be conveyed to swales proposed north of Tomahawk Island Drive. These facilities would take advantage of ODOT's existing 21-inch and 27-inch diameter stormwater outfalls on the Columbia River (CR7/8).

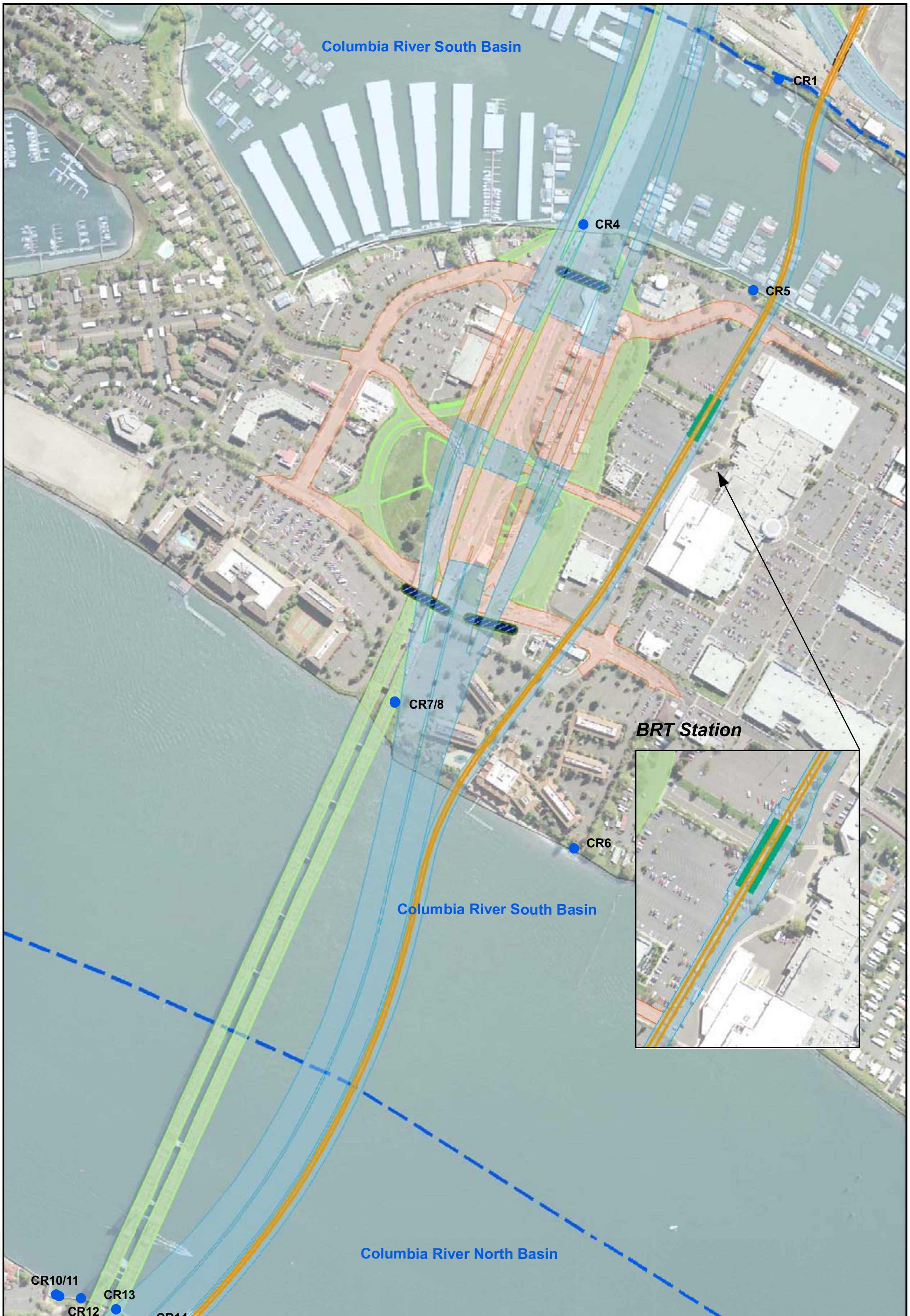
For Alternatives 2 & 3, approximately 15.3 acres would be conveyed to multiple biofiltration swales in north of the new Tomahawk Island Drive. For Alternatives 4 & 5, the area would be about 22.6 acres, and includes portions of the southbound highway lanes and the existing Columbia River Bridges. Tomahawk Island Drive, a new street, is significantly below existing ground and runoff (and possibly groundwater seepage) would need to be pumped to one of these swales.

Runoff from ramps between I-5 and Jantzen Drive would be conveyed to one or more swales located adjacent to Jantzen Drive. The impervious area served by the swale(s) would be about 4.3 acres for Alternatives 2 & 3, and about 5.6 acres for Alternatives 4 & 5. An existing outfall, CR4, may need to be enlarged to handle runoff to North Portland Harbor.

4.3.3.2 Transit

Runoff from the elevated HCT guideway would be conveyed to the Expo Station (at the Marine Drive interchange area) as described in Section 4.3.2.

[35] http://egov.oregon.gov/OWRD/GW/index.shtml



0 100 200 300
Feet

Bridge
Pavement
Tunnel
Tunnel Location
Existing Pavement Removed
Park and Ride
Transit Platform
Transit Guideway
Outfall
Drainage Basin Boundary
Swale

Exhibit 4-4a: Stormwater Facilities
Columbia Slough South Basin (1 of 3)
Alternatives 2 and 3 - Hayden Island
Downstream River Crossing

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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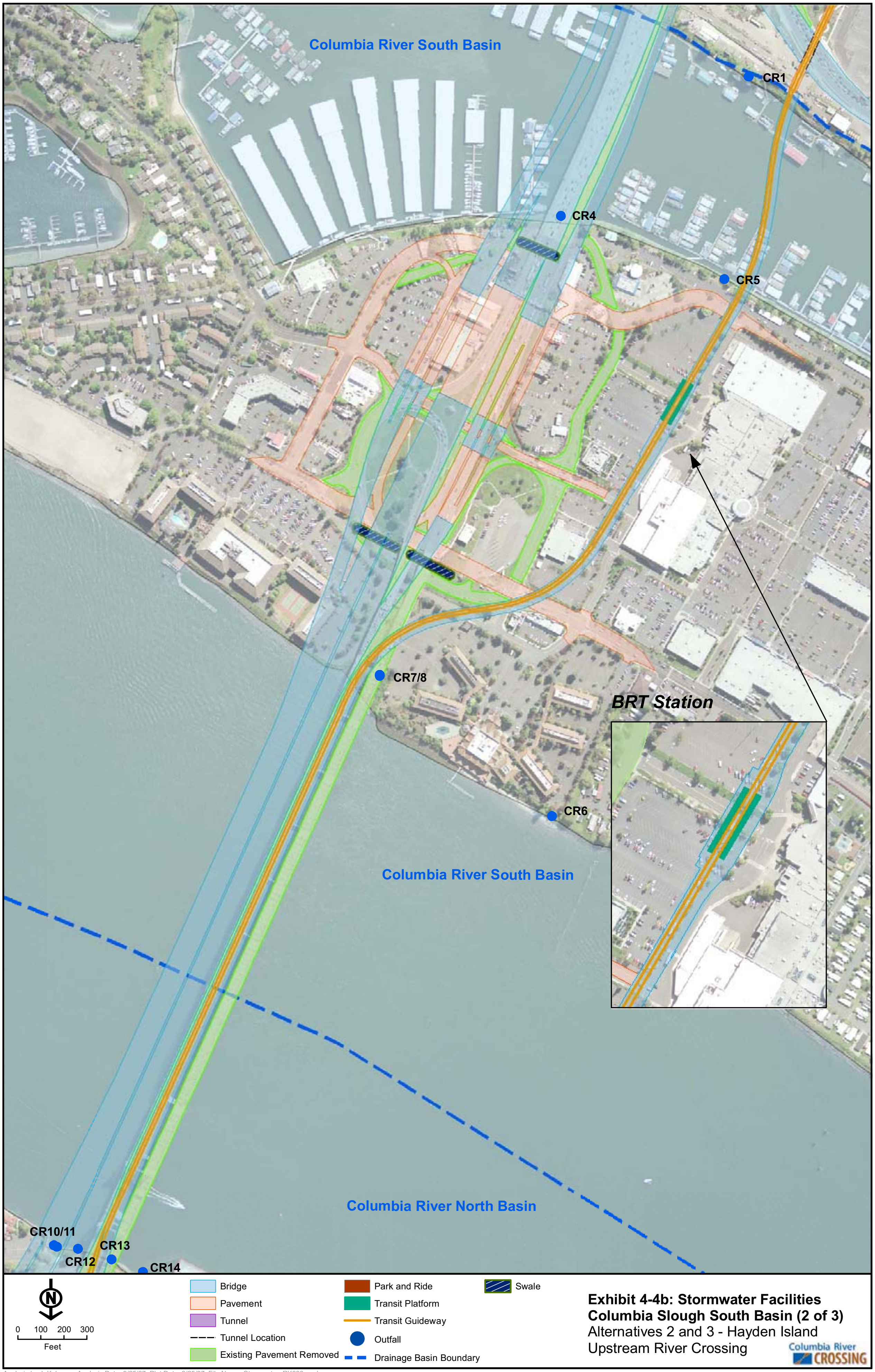

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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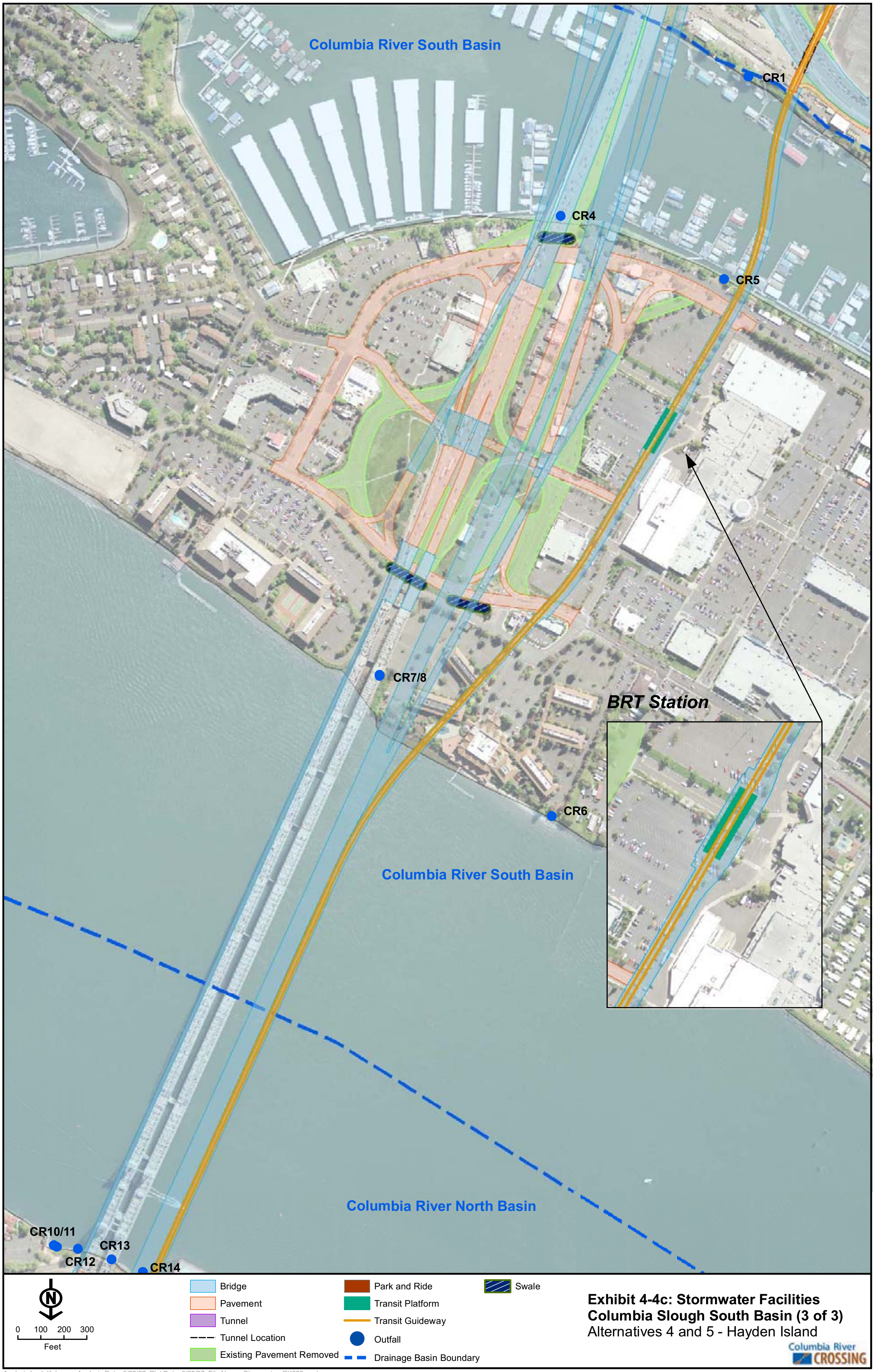

Exhibit 4-4c: Stormwater Facilities
Columbia Slough South Basin (3 of 3)
Alternatives 4 and 5 - Hayden Island

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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4.3.3.3 Water Quality Facilities

The following exhibit lists the proposed water quality swales shown on Exhibits 4-4a and 4-4b for Alternatives 2 & 3, and Exhibit 4-4c for Alternatives 4 & 5.

Exhibit 4-5: Water Quality Facilities – Hayden Island Interchange

Mode	Impervious Area (acres)	Proposed Water Quality Swales*	Outlet	Comments
Alternatives 2 & 3				
Highway	4.3	1 – 25' x 100'	CR-4	Serves Jantzen Drive and ramps sloping to Jantzen Drive.
Highway	15.3	2 – 25' x 120'	CS-7/8	Serves Tomahawk Island and Hayden Island Drives, and ramps draining to Hayden Island Drive..
Alternatives 4 & 5				
Highway	5.6	1 – 25' x 110'	CS-4	Serves Jantzen Drive and ramps sloping to Jantzen Drive.
Highway	22.6	2 – 25' x 140'	CS-7/8	Serves Tomahawk Island and Hayden Island Drives, and ramps draining to Hayden Island Drive.

** The dimensions shown are for the swale invert.*

Note that the facilities listed for Alternatives 2 & 3 are for the downstream bridge alignment. As noted in the preceding subsections, there is little difference in impervious areas between the downstream and upstream alignments.

4.3.4 Columbia River North Basin (Vancouver)

Exhibits 4-6a through 4-6e present the major elements of the proposed stormwater management system in the Columbia River North Basin. As shown on Exhibits 4-6a and 4-6b there are significant differences between interchange and transit layouts south of Mill Plain Boulevard for Alternative 2 and 3 depending on the Columbia River bridge alignment. There are also significant differences between the replacement and supplemental Columbia River bridge alternatives as shown on Exhibits 4-6a through 4-6c.

The total new and reconstructed impervious area draining to or within this basin from roadways and HCT guideways is approximately 105.2 acres for Alternatives 2 & 3 and about 95.2 acres for Alternatives 4 & 5. Despite the differences in interchange layout for the downstream and upstream bridge alignments for Alternatives 2 & 3, there is no appreciable difference in area.

4.3.4.1 Roadways

As discussed in Section 2.6.2, runoff from more than 250 acres in downtown Vancouver and adjacent neighborhoods to the north and west is conveyed to the Columbia River (outfalls CR10/11) via the existing I-5 stormwater system. Water quality treatment is not currently provided and it is recommended that a new stormwater conveyance system be constructed to collect only highway runoff. This will enable highway runoff to be treated by separating it from drainage from outside the highway right-of-way. The existing drainage system would be retained to convey runoff from downtown Vancouver and adjacent neighborhoods as well as treated runoff from the highway.

For all alternatives, runoff from this segment of I-5 would drain to a low point in the vertical profile of I-5 at about Sixth Street. For water quality purposes, this portion of I-5 may be divided into the following three sub-basins:

- north of Fourth Plain interchange
- between Fourth Plain and Mill Plain interchanges
- south of Mill Plain interchange, including the SR 14 interchange

North of Fourth Plain Interchange

The total area of new and reconstructed impervious pavement in this segment would be 19.2 acres for Alternatives 2 & 3 and 17.9 acres for Alternatives 4 & 5.

At this time, it is assumed that the conveyance system for Fourth Plain Boulevard east of I-5, which collects runoff from approximately 2000 feet of the street, be retained and runoff continue to be discharged untreated to the existing WSDOT drainage system under I-5. Any work required on this portion of Fourth Plain Boulevard is expected to be limited to resurfacing approximately 2.4 acres of existing pavement. This assumption will be revisited as design work progresses.

Runoff from the highway north of Fourth Plain and ramps west of I-5 would be conveyed to one of two biofiltration swales located immediately east of I-5. The impervious areas served would be 16.8 and 15.5 acres for Alternatives 2 & 3 and Alternatives 4 & 5, respectively. One swale would be north of Fourth Plain and the other would be located to the south. Treated flows from the swales would be discharged to the existing 36-inch diameter WSDOT stormwater pipe under I-5. This pipe is part of the existing drainage system described above.

Between Fourth Plain and Mill Plain Interchanges

The total area of new and reconstructed impervious pavement in this segment would be 26.3 acres for Alternatives 2 & 3 and 21.2 acres for Alternatives 4 & 5.

The impervious area for I-5 and associated ramps between Fourth Plain and Mill Plain interchanges would be about 11.8 acres for Alternative 3 & 3 and 10.3 acres for Alternatives 4 & 5. Runoff from these areas would be conveyed to swales located adjacent to the ramps north of Mill Plain Boulevard. Flows treated by these swales would include runoff from ramps east of I-5 and immediately south of Fourth Plain (about 1.8 acres), but not the ramps at the interchange and reconstructed Mill Plain Boulevard. Runoff from approximately 4.5 acres of I-5 mainline immediately north and south of the Mill Plain bridge would be treated in a swale adjacent to the ramp between Mill Plain and southbound I-5. It is assumed that runoff from the ramps north and south of Mill Plain Boulevard (approximately 3.2 acres) would be treated using swales located adjacent to the boulevard.

At this time, it is assumed that existing conveyance system serving about 3.5 acres of reconstructed pavement on Mill Plain Boulevard would be retained and runoff discharged untreated to the existing WSDOT drainage system under I-5. Again, this assumption will be revisited as design work progresses.

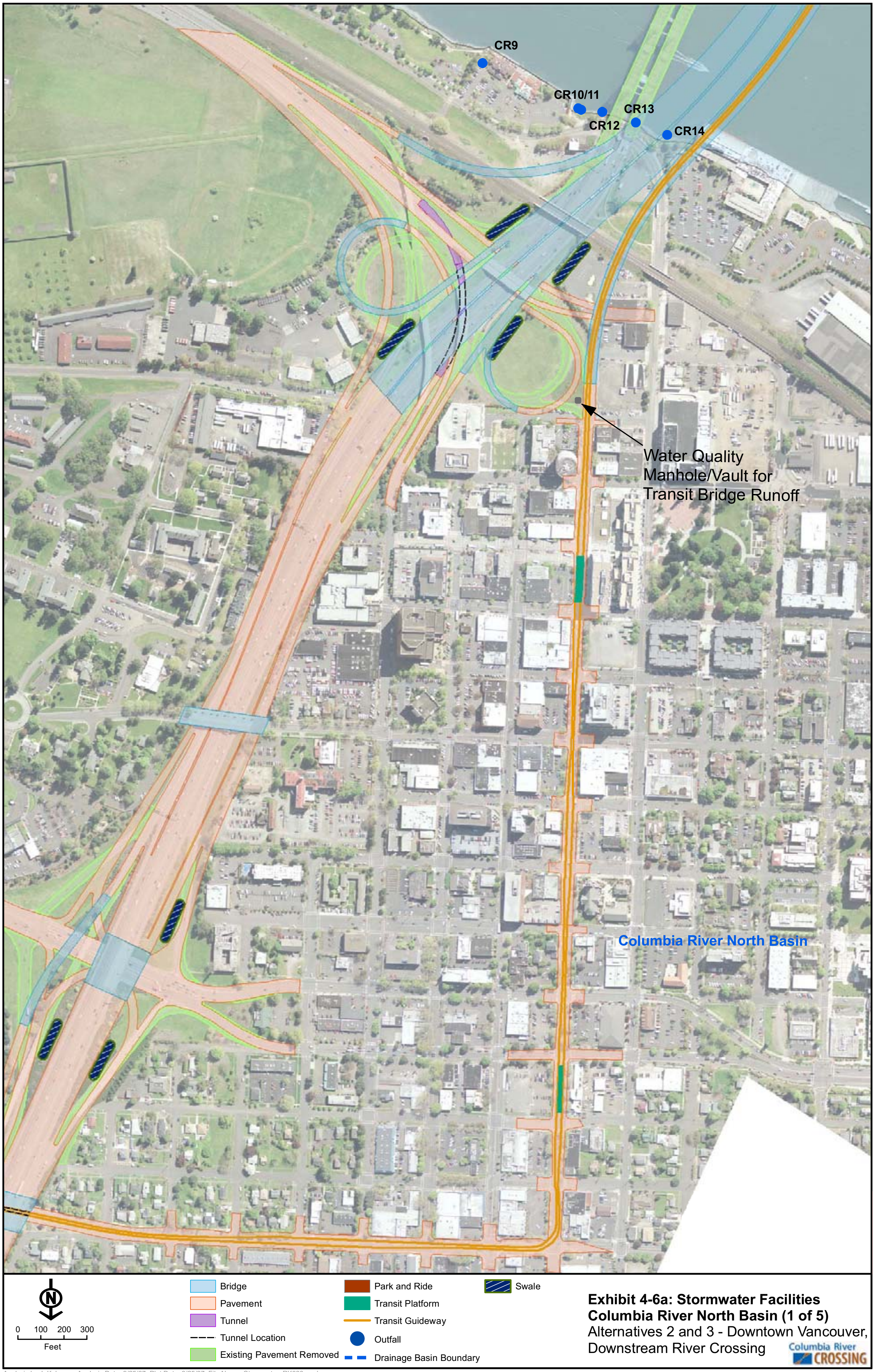

Exhibit 4-6a: Stormwater Facilities Columbia River North Basin (1 of 5)
Alternatives 2 and 3 - Downtown Vancouver, Downstream River Crossing

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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Exhibit 4-6b: Stormwater Facilities
Columbia River North Basin (2 of 5)
Alternatives 2 and 3 - Clark College

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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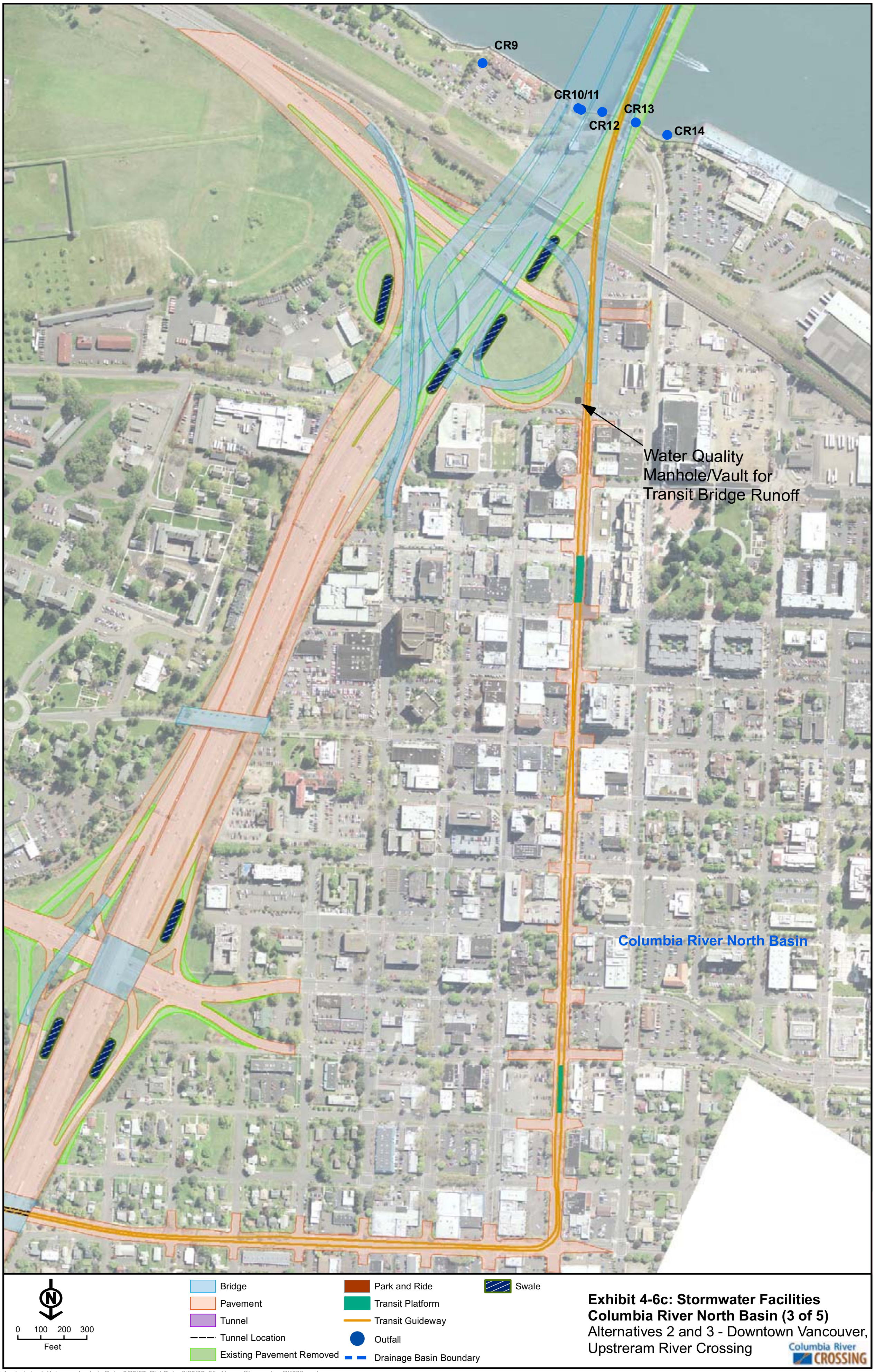

Exhibit 4-6c: Stormwater Facilities
Columbia River North Basin (3 of 5)
Alternatives 2 and 3 - Downtown Vancouver,
Upstreram River Crossing

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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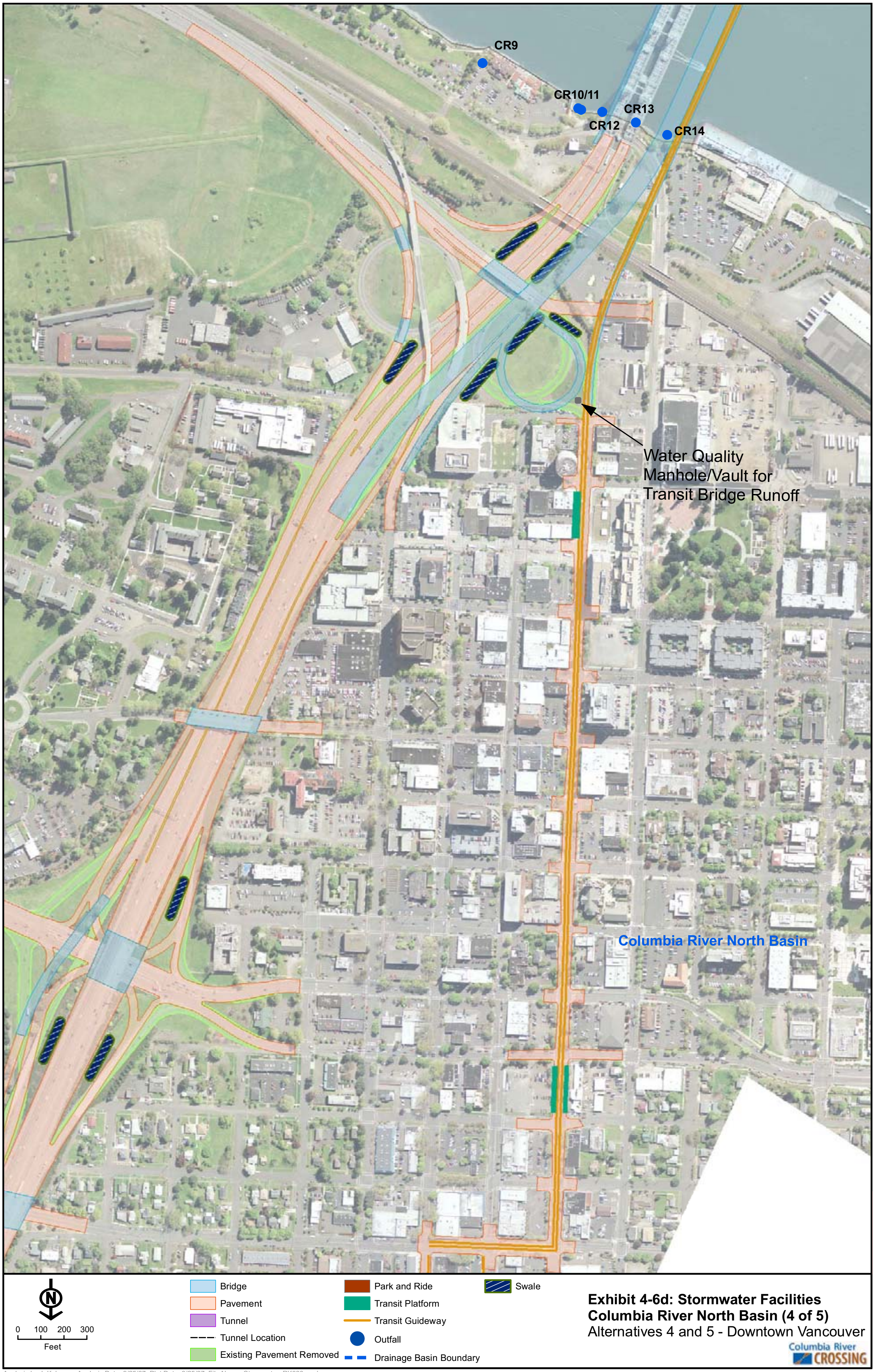

Exhibit 4-6d: Stormwater Facilities
Columbia River North Basin (4 of 5)
Alternatives 4 and 5 - Downtown Vancouver

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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0 100 200 300
Feet

Bridge
Pavement
Tunnel
Tunnel Location
Existing Pavement Removed
Park and Ride
Transit Platform
Transit Guideway
Outfall
Drainage Basin Boundary
Swale

Exhibit 4-6e: Stormwater Facilities
Columbia River North Basin (5 of 5)
Alternatives 4 and 5 - Clark College

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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Flows from all swales would be discharged to an existing 36/42-inch diameter stormwater pipe under I-5. Again, this pipe is part of the WSDOT drainage system described in the preceding paragraphs. The stormwater pipe serving Mill Plain Boulevard may need to be replaced to accommodate the boulevard's lower vertical profile under I-5. Elevation differences appear to be adequate to allow runoff from the boulevard to be discharged to the existing 36/42-inch diameter trunk line under I-5; there is a difference of approximately six feet between the lowest ramp elevation and invert of the nearby trunk line. In addition, the trunk line may need to be moved east of its present location to accommodate the boulevard's lower vertical profile and the diameter of the pipe immediately downstream increased to maintain current flow capacity.

South of Mill Plain Interchange

The total area of new and reconstructed impervious pavement in this segment would be 36.5 acres for Alternatives 2 & 3 and 37.5 acres for Alternatives 4 & 5. The areas include I-5 and associated ramps south of the Mill Plain interchange, and collector/distributor roads either side of the highway.

Parts of SR 14 and the ramps between SR 14 and I-5 slope east towards the SR 14 conveyance system; this system discharges to the Columbia River at outfall CR9. At this time, it is assumed that runoff to this system would continue to be discharged untreated into the Columbia River. It is also assumed that balance of SR14, which naturally drains to the west, would be conveyed to the existing City of Vancouver drainage system on Columbia Street before being discharged untreated to outfall CR 17. Again, these assumptions will be revisited as design work progresses.

Runoff from I-5 from the balance of this segment would be discharged to a water quality swales located in the SR 14 interchange area. The total impervious areas that would receive water quality treatment are: 36.3 acres for Alternatives 2 & 3 and 31.4 acres for Alternatives 4 & 5. Treated flows from the swales would be released to the Columbia River via existing stormwater outfalls CR13/14.

For Alternatives 4 & 5, it has been assumed that runoff from the north half of the existing bridges would be collected and treated. The lift spans, however, may make this difficult to accomplish. Runoff would need to be conveyed along the shoulders until it can be picked up by inlets located north of the lift spans or, should a conveyance system be provided, special joints would need to be installed between the fixed and moveable spans. In either case, runoff would not be collected when the lift spans are open. Under such circumstances, runoff would flow into the Columbia River from the openings on the south side of the lift spans.

4.3.4.2 Transit

Runoff from the elevated HCT guideway from the high point on the Columbia River Bridge to Fifth Street (about 2.6 acres for Alternatives 2 & 3 and 1.8 acres for Alternatives 4 & 5) would be discharged to a swale in the SR 14 interchange area. Treated flows from this swale would be released to the Columbia River at outfall CR15 assuming the City of Vancouver 16-inch diameter stormwater pipe has adequate capacity.

Through Vancouver, the HCT guideway is on existing city streets and it is assumed that low mountable curbs would be used between intersections to discourage vehicles entering the guideway from the adjacent pavement. This approach would also facilitate separating guideway runoff from street drainage, something that would be very difficult to achieve should rumble strips be used in lieu of curbs. This would be particularly true for BRT where a standard crowned street cross-section would probably be used.

Runoff from the north half of the Columbia River Bridge would be treated in a water quality vault located at the north end of the approach. The impervious area draining to this vault is approximately 2.7 acres for Alternatives 2 & 3 and 1.4 acres for Alternatives 4 & 5. The HCT alignments north of the bridge for Alternatives 2 & 3 and Alternative 4 & 5 are very different, and the proposed runoff management strategies are presented separately in the following paragraphs.

Alternatives 2 & 3

Based on current layouts, the exiting vertical profile of Washington Street and McLoughlin Boulevard would not be altered except where McLoughlin passes under I-5. It is recommended that existing stormwater systems be used to receive drainage from the guideway (about 3.3 acres). HCT construction would not increase the impervious area or runoff from these streets. The existing drainage systems discharge to the Columbia River at outfalls CR 13/14, CR17 and CR19. Water quality manholes would be provided to treat runoff from the guideway before it would be discharged to the city stormwater system. This assumes that the existing pipes are located deep enough to accommodate any drop in hydraulic grade across the manholes, an assumption that will need to be validated.

Stormwater pipes serving McLoughlin Boulevard may need to be replaced to accommodate a lower vertical road profile. Pumping will likely be required as there would only be a vertical difference of 3 feet between the low point on McLoughlin where it runs under I-5 and the invert of the nearby existing trunk sewer. As a result, runoff from approximately 200 feet of guideway would not be treated.

Between McLoughlin Boulevard and the high point of the HCT bridge across the SR 500 interchange (about 9.9 acres), it is assumed that guideway runoff would be conveyed to the existing I-5 drainage system at McLoughlin. It would also be feasible for part of the runoff to be conveyed to the I-5 system at Fourth Plain Boulevard. With the exception of the short length of guideway under I-5, water quality manholes are proposed to treat runoff. Depending on the final layout, it may be feasible to use swales to treat runoff from the 4.6 acre Clark College Park and Ride.

Alternative 4 & 5

Like Alternatives 2 & 3, the existing vertical profiles of Washington Street, Broad Street and Main Street would not be altered based on current layouts. Runoff from approximately 5.8 acres of guideway would be conveyed to the existing city stormwater system since HCT construction would not increase the impervious area or runoff from these streets. Again, water quality manholes would be provided for drainage before it being discharged to the city stormwater system. This assumes that the existing pipes are located deep enough to accommodate any drop in hydraulic grade across the manholes, an assumption that will need to be validated.

Runoff from the Clark College Park and Ride (about 5.9 acres) would be conveyed to the existing I-5 drainage system at McLoughlin Boulevard. Depending on the final layout, either water quality manholes and/or swales would be used to treat runoff.

4.3.4.3 Water Quality Facilities

The following exhibit lists the proposed water quality swales shown on Exhibits 4-6a and 4-6b for Alternatives 2 & 3, and Exhibit 4-6c for Alternatives 4 & 5. As noted in the preceding subsections, there is little appreciable difference in impervious areas between the downstream and upstream alignments for Alternatives 2 & 3.

Exhibit 4-7a: Water Quality Facilities – SR 14 Interchange

Mode	Impervious Area (acres)	Proposed Water Quality Swales*	Outlet	Comments
Alternatives 2 & 3				
Highway	30.8	3 – 25’ x 145’	CR-13/14	Serves I-5 between crest of Columbia River Bridges and Mill Plain, distributor/collector west of I-5, and ramps at SR 14 interchange.
Highway	5.5	1 – 25’ x 115’	CR-13/14	Serves collector/distributor east of I-5.
Alternatives 4 & 5				
Highway	22.5	3 – 25’ x 130’	CR-13/14	Serves I-5 between crest of Columbia River Bridges and Mill Plain, distributor/collector west of I-5, and ramps at SR 14 interchange.
Highway	5.7	1 – 25’ x 115’	CR-13/14	Serves collector/distributor east of I-5.
Highway	2.2	1 – 10’ x 110’	CR-13/14	Loop ramp west of I-5.
Highway	0.8	1 – 8’ x 100’	CR-13/14	C Street and associated ramps.

** The dimensions shown are for the swale invert.*

Exhibit 4-7b: Water Quality Facilities – Mill Plain Interchange

Mode	Impervious Area (acres)	Proposed Water Quality Swales*	Outlet	Comments
Alternatives 2 & 3				
Highway	4.5	1 – 25’ x 110’	CR-4	Serves I-5 mainline between ramps.
Highway	11.8	2 – 25’ x 120’	CS-5	Serves I-5 mainline between Mill Plain and Fourth Plain.
Alternatives 4 & 5				
Highway	4.5	1 – 25’ x 110’	CS-4	Serves I-5 mainline between ramps.
Highway	10.3	2 – 25’ x 110’	CS-5	Serves I-5 mainline between Mill Plain and Fourth Plain.

** The dimensions shown are for the swale invert. Lengths are rounded to the nearest 5 feet.*

Exhibit 4-7c: Water Quality Facilities – Fourth Plain Interchange

Mode	Impervious Area (acres)	Proposed Water Quality Swales*	Outlet	Comments
Alternatives 2 & 3				
Highway	16.8	2 – 25’ x 135’	CR-4	Serves I-5 mainline north of Fourth Plain and ramps west of I-5.
Alternatives 4 & 5				
Highway	15.5	2 – 25’ x 130’	CS-4	Serves I-5 mainline north of Fourth Plain and ramps west of I-5.

** The dimensions shown are for the swale invert.*

4.3.5 Burnt Bridge Creek Basin

Exhibits 4-8a and 4-8b present the major elements of the proposed stormwater management system in the Burnt Bridge Creek Basin. The total new and reconstructed impervious area within this basin would be about 32.0 acres for Alternatives 2 & 3 and about 44.0 acres for Alternatives 4 & 5. The difference in area is mainly the result of the reconstruction of Main Street and proposed Park and Ride facility at Lincoln for Alternatives 4 & 5; these items would not be required for Alternatives 2 & 3.

As noted elsewhere, stormwater runoff in this basin will require both flow control and water quality treatment.

4.3.5.1 Roadways

Approximately 25.9 acres of new and reconstructed impervious areas comprises highway pavement for Alternatives 2 & 3 and 23.3 acres for Alternatives 4 & 5.

It is proposed that the existing general stormwater flow patterns and stormwater conveyance system be retained to the maximum extent practical. This will simplify conveying runoff to the two existing stormwater ponds serving this area. Note that the stormwater conveyance system along I-5 within this segment also serves approximately 30 acres of urban development west of the highway right-of-way.

Drainage from the tunnel between southbound I-5 to eastbound SR 500 may need to be pumped to the existing stormwater trunk main serving I-5. Based on current arrangements, the area that could contribute to runoff into the tunnel is only about 0.1 acre, and the only other drainage anticipated would be seepage and water used in the unlikely event of a fire.

For all alternatives, it is proposed that the stormwater retention pond located east of I-5 and south of the Main Street interchange, and detention pond located at NE 15th Avenue and NE 41st Circle be expanded to accommodate any increase in flows. The stormwater pond at the Main Street interchanges serves I-5 and most of the SR 500 interchange. The pond at NE 15th Avenue serves the east side of the SR 500 interchange and SR 500.

4.3.5.2 Transit

Runoff from the guideway, terminus and park and ride structures would also be treated before being discharged to existing stormwater systems on Main Street. This stormwater system conveys runoff north to 45th Street where it is discharged via a drainage ditch to a low area in Kiggins Bowl adjacent to I-5. Runoff to this low area drains under I-5 to Burnt Bridge Creek via an 18-inch diameter culvert.

Exhibit 4-8a: Stormwater Facilities
Burnt Bridge Creek Basin (1 of 2)
Alternatives 2 and 3 - Lincoln Area

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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Exhibit 4-8b: Stormwater Facilities
Burnt Bridge Creek Basin (2 of 2)
Alternatives 4 and 5 - Lincoln Area

Columbia River CROSSING

Analysis by J. Koloszar; Analysis Date: 9/25/07; Plot Date: 9/25/07; File Name: Stormwater_RK080.mxd

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4.3.6 Summary

The existing and new impervious areas are summarized on Exhibit 4-9. It can be seen from the exhibit that for Alternatives 2 & 3, the overall increase in impervious area is 58 acres or 33 percent, and the area treated is approximately 3.3 times the net new impervious area. For Alternatives 4 & 5, the values are 50 acres, 27 percent and 3.9 times, respectively. Note that the values presented are considered to be conservative as they do not include any benefit from non-road impervious areas (for example, buildings and parking lots) that might be acquired, converted to pervious surfaces and re-vegetated.

Exhibit 4-9: Net New Impervious Areas

Basin	Existing Area (acres)	Proposed Area (acres)	Increase in Area (percent)	Net New Area (acres)	Area Treated	
					(acres)	(% Net New)
Alternatives 2 & 3						
Columbia Slough	37.3 acres	68.5 acres	84 percent	31.2 acres	56.0 acres	180 percent
Columbia River South	18.9 acres[1]	19.6 acres	4 percent	0.5 acres	19.6 acres	3,900 percent
Columbia River North	94.6 acres	113.6 acres	20 percent	19.0 acres	84.0 acres	440 percent
Burnt Bridge Creek	24.5 acres[2]	32.0 acres	31 percent	7.5 acres	32.0 acres	430 percent
Overall	**175 acres**	**234 acres**	**33 percent**	**58 acres**	**192 acres**	**330 percent**
Alternatives 4 & 5						
Columbia Slough	33.2 acres	58.6 acres	77 percent	25.4 acres	46.1 acres	180 percent
Columbia River South	18.9 acres[1]	28.2 acres	49 percent	9.3 acres	28.2 acres	300 percent
Columbia River North	94.6 acres	105.9 acres	12 percent	11.3 acres	78.5 acres	690 percent
Burnt Bridge Creek	39.7 acres	44.0 acres	11 percent	4.3 acres	44.0 acres	1,020 percent
Overall	**186 acres**	**237 acres**	**27 percent**	**50 acres**	**197 acres**	**390 percent**

1. *Includes 6.0 acres for streets and area under HCT guideway with poorly-defined drainage systems.*
2. *Does not include 15.2 acres for WSDOT Maintenance Facility and Main Street.*

Exhibit 4-10a presented the water quality treatment proposed for new and reconstructed impervious pavement and guideway for Alternatives 2 & 3. Outfall locations and extent of impervious areas may bee seen on Exhibits 4-2, 4-4, 4-6 and 4-8. Exhibit 4- 10b presents anticipated changes in impervious area between existing and developed conditions for Alternatives 4 & 5.

The areas presented in Exhibits 4-10a and 4-10b are those within the project footprint used for this report and do not necessarily reflect the total area draining to individual outfalls. Also note that the areas do not include roadway surfaces located beneath bridges. While those areas may be pollution-generating surfaces, they do not contribute to the volume or rate of runoff used to estimate the size of stormwater conveyance infrastructure and water quality facilities.

4.4 Operations and Maintenance

Operating and maintenance activities with potential stormwater-related impacts include sanding and spill control. In addition, inadequate design, poor construction or the lack of maintenance of constructed BMPs and other drainage facilities could result in increased sediment from erosion on embankment slopes and in drainage channels.

Source control BMPs that might be appropriate for maintenance and operations are those related to street sweeping at interchanges and on urban roads, spill control, and de-icing. Sweeping was not considered for the I-5 mainline due to the speed and volume of traffic.

Facility-specific Operation and Maintenance Manuals would be prepared for all BMPs. The manuals would provide requirements for inspection and measures to correct defects or problems.

Exhibit 4-10a: Impervious Areas for Alternatives 2 & 3

Project Segment & Outfall	Roadway Area (acres)			Transit Area (acres)			Comments
	Untreated	Treatment Provided	Total	Untreated	Treatment Provided	Total	
Columbia Slough Basin							
- CS1	-	5.8	5.8	-	-	-	Existing water quality manhole would be enlarged to handle increased impervious area.
- CS2	N/A	N/A	N/A	N/A	N/A	N/A	Contributing area probably not affected by project.
- CS3	6.9	-	6.9	-	-	-	About 1.9 acres of existing pavement would be reconstructed. The existing drainage system would be retained and runoff would not be treated.
- CS4	1.5	5.8	7.3	-	-	-	Area does not include the Marine Drive connector (see *Unknown*). Basic treatment would be provided by a biofiltration swale.
- CS5	-	37.2	37.2	-	-	-	Basic treatment would be provided by biofiltration swales. Area includes I-5 mainline on and south of the Columbia River Bridges.
- CS6	-	-	-	-	-	-	There would not be any impervious area contributing to this outfall.
- CS7	-	-	-	-	7.2	7.2	Transit area includes Hayden Island and south part of Columbia River HCT bridge. Area shown is for LRT – increase by 1.1 acre for BRT.
- Other	1.8	-	1.8	-	-	-	Drains to Portland stormwater system on Marine Dr. and includes about 1.1 acres of existing pavement. Outfall and treatment provided not determined.
- CR1	-	-	-	-	-	-	There would not be any impervious area contributing to this outfall.
- CR2	N/A	N/A	N/A	N/A	N/A	N/A	Contributing area not affected by project.
- CR3	2.3	-	2.3	-	-	-	
Sub-total for Basin	12.5	48.8	61.3	-	7.2	7.2	
Columbia River South Basin							
- CR4	-	4.3	4.3	-	-	-	The existing outfall may need to be enlarged. Basic treatment would be provided by a biofiltration swale.
- CR5	-	-	-	-	-	-	Contributing area reduced by transit bridge footprint.
- CR6	N/A	N/A	N/A	N/A	N/A	N/A	Contributing area probably not affected by project.
- CR7/8	-	15.3	15.3	-	-	-	Basic treatment would be provided by biofiltration swales.
- Other	-	-	-	-	-	-	Assumed that there would not be any impervious area. This will depend on land use decisions.
Sub-total for Basin	-	19.6	19.6	-	-	-	
Columbia River North Basin							
- CR9	4.2	-	4.2	-	-	-	The existing SR 14 conveyance system would be retained. No water quality treatment is currently provided or proposed.
- CR10	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR11	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR12	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR13/14				4.2	10.9	15.1	Basic treatment using water quality manholes assumed for HCT guideway and Clark College park & ride only.
South of Mill Plain	-	36.3	36.3	-	2.7	2.7	Includes north half of Columbia River HCT bridge. Basic treatment would be provided by biofiltration swales.
Mill Plain interchange	3.5	3.2	6.7	-	-	-	It is not feasible to treat runoff from Mill Plain. Assumed that ramps will be provided with basic treatment in in-field areas.
Mill Plain to Fourth Plain	2.4	11.8	14.2	-	-	-	Basic treatment would be provided by biofiltration swales at Mill Plain interchange. Fourth Plain east of I-5 would not be treated – it is part of a larger city system.
North of Fourth Plain	-	16.8	16.8	-	-	-	Basic treatment would be provided by a biofiltration swale at the Fourth Plain interchange.
- CR15	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR16/17	0.5	-	0.5	1.7	0.8	2.5	Runoff from SR 14 would be directed to the existing Columbia St. conveyance system. Basic treatment using water quality manholes assumed for HCT guideway.
- CR18	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR19	-	-	-	13.1	1.5	14.6	Basic treatment using water quality manholes assumed for HCT guideway.
Sub-total for Basin	10.6	68.1	78.7	19.0	15.9	34.9	
Burnt Bridge Creek Basin							
- BB1	-	7.9	7.9	-	-	-	An existing wet pond would be enlarged, if necessary, to handle additional flows.
- BB2	-	18.0	18.0	-	-	-	An existing infiltration pond would be enlarged, if necessary, to handle additional flows
- Other	-	-	-	-	6.1	6.1	Assumed runoff would be dispersed in Kiggins Bowl area. Area includes HCT bridge over SR 500 interchange.
Sub-total for Basin	-	25.9	25.9	-	6.1	6.1	
TOTAL FOR PROJECT	**23**	**162**	**185**	**19**	**29**	**48**	

Exhibit 4-10b: Impervious Area for Alternatives 4 & 5

Project Segment & Outfall	Roadway Area (acres)			Transit Area (acres)			Comments
	Untreated	Treatment Provided	Total	Untreated	Treatment Provided	Total	
Columbia Slough Basin							
- CS1	-	5.8	5.8	-	-	-	Existing water quality manhole would be enlarged to handle increased impervious area.
- CS2	N/A	N/A	N/A	N/A	N/A	N/A	Contributing area probably not affected by project.
- CS3	6.9	-	6.9	-	-	-	About 1.9 acres of existing pavement would be reconstructed. The existing drainage system would be retained and runoff would not be treated.
- CS4	1.5	9.4	10.9	-	-	-	Area does not include the Marine Drive connector (see *Unknown*). Basic treatment would be provided by a biofiltration swale.
- CS5	-	19.5	19.5	-	-	-	Basic treatment would be provided by biofiltration swales.
- CS6	-	-	-	-	-	-	There would not be any impervious area contributing to this outfall.
- CS7	-	4.6	4.6	-	6.8	6.8	Transit area includes Hayden Island and south part of Columbia River HCT bridge. Area shown is for LRT – increase by 1.1 acre for BRT.
- Other	1.8	-	1.8	-	-	-	Drains to Portland stormwater system on Marine Dr. and includes about 1.1 acres of existing pavement. Outfall and treatment provided has not been determined.
- CR1	-	-	-	-	-	-	There would not be any impervious area contributing to this outfall.
- CR2	N/A	N/A	N/A	N/A	N/A	N/A	Contributing area not affected by project.
- CR3	2.3	-	2.3	-	-	-	
Sub-total for Basin	12.5	39.3	51.8	-	6.8	6.8	
Columbia River South Basin							
- CR4	-	5.6	5.6	-	-	-	The existing outfall may need to be enlarged. Basic treatment would be provided by a biofiltration swale.
- CR5	-	-	-	-	-	-	Contributing area reduced by transit bridge footprint.
- CR6	N/A	N/A	N/A	-	-	-	Contributing area probably not affected by project.
- CR7/8	-	22.6	22.6	-	-	-	Basic treatment would be provided by biofiltration swales.
- Other	-	-	-	-	-	-	Assumed that there would not be any impervious area. This will depend on land use decisions.
Sub-total for Basin	-	28.2	28.2	-	-	-	
Columbia River North Basin							
- CR9	5.2	-	5.2	-	-	-	The existing SR 14 conveyance system would be retained. No water quality treatment is currently provided or proposed.
- CR10	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR11	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR12	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR13/14				4.7	6.1	10.8	Basic treatment using water quality manholes assumed for HCT guideway and Clark College park & ride only.
South of Mill Plain	-	31.2	31.2	-	1.4	1.4	Includes north half of Columbia River HCT bridge. Basic treatment would be provided by biofiltration swales.
Mill Plain interchange	3.5	3.2	6.7	-	-	-	It is not feasible to treat runoff from Mill Plain. Assumed that ramps will be provided with basic treatment in in-field areas.
Mill Plain to Fourth Plain	2.4	14.8	17.2	-	-	-	Basic treatment would be provided by biofiltration swales at Mill Plain interchange. Fourth Plain east of I-5 would not be treated – it is part of a larger city system.
North of Fourth Plain	-	15.5	15.5	-	-	-	Basic treatment would be provided by a biofiltration swale at the Fourth Plain interchange.
- CR15	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR16/17	0.8	-	0.8	1.7	0.8	2.5	Runoff from SR 14 would be directed to the existing Columbia St. conveyance system. Basic treatment using water quality manholes assumed for HCT guideway.
- CR18	-	-	-	-	-	-	Contributing area probably not affected by project.
- CR19	-	-	-	9.1	5.5	14.6	Basic treatment using water quality manholes assumed for HCT guideway.
Sub-total for Basin	11.9	64.7	76.6	15.5	13.8	29.3	
Burnt Bridge Creek Basin							
- BB1	-	7.1	7.1	-	-	-	An existing wet pond would be enlarged to handle additional flows.
- BB2	-	16.2	16.2	-	-	-	An existing infiltration pond would be enlarged to handle additional flows
- Other	-	-	-	-	20.7	20.7	Assumed runoff would be dispersed in Kiggins Bowl area.
Sub-total for Basin	-	23.3	23.3	-	20.7	20.7	
TOTAL FOR PROJECT	**24**	**156**	**180**	**16**	**41**	**57**	